Process for product development for a case company

Improving product development through
management of foresight, technology roadmap and product portfolio

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Master's thesis

Degree Programme in Strategic Leadership of Technology-Based Business

Visamäki, spring 2018

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VISAMÄKI
Degree Programme in Strategic Leadership of Technology-Based Business

Author Mika Korhonen **Year** 2018

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ABSTRACT

Most successful people begin with two beliefs: the future can be better than the present, and I have the power to make it so. They are often showered by good fortune, but rely at crucial moments upon achievements of individual will. (Gladwell 2009)

This thesis addresses a confidential case company problem of not having a forward-looking **Process for product development.** It has an object of considering relevant theory of futurology and supplemented by technology road mapping and product platform theories comes up with a proposal for a process the case company can elect to use when considering the future needs for product development in a strategic way.

Theoretical framework for the thesis comes from a comprehensive literature review enriched by researchers existing expertise on the applicable market that is railway rolling stock subsystems. Methodology choices are explained in the first chapter.

The main findings of the thesis are that a company can benefit in many ways from having a forward-looking product development system that is well embedded in the strategy of the company and proposes a strategy process and tools to be applied in the case company when considering the future product development ideas.

Although there is plenty of research done in the areas of product development and technology, product and innovation portfolios there is still a need to research further e.g. the barriers of adaption for futures methodologies and for applying a more scientific approach to forecasting which is the basis for product development.

Keywords Product portfolio, technology roadmap, foresight, strategy

Pages 114 pages + appendices 3 pages

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TIIVISTELMÄ

VISAMÄKI
Teknologiaosaamisen johtaminen

Tekijä Mika Korhonen **Vuosi** 2018

Työn nimi Tuotekehitysprosessi kohdeyritykselle
Tuotekehityksen tehostaminen tulevaisuustiedon, teknologiakartan ja tuoteportfolioajattelun kautta

TIIVISTELMÄ

Useimmat menestyvät ihmiset uskovat tulevaisuuden osalta kahteen asiaan: tulevaisuus on parempi kuin nykyisyys ja itsellä on mahdollisuus vaikuttaa siihen. Heillä on usein hyvää onnea, mutta hetkinä joina menestys luodaan he osoittavat henkilökohtaista tahtoa. (vapaasti käännetty Gladwell 2009)

Tässä opinnäytteessä käsitellään luottamuksellisen yrityksen tapausta jossa tuotekehitysprosessi ei ole erityisen tulevaisuuteen suuntaava tarkastelussaan. Opinnäytteen tavoitteena on tutustua soveltuvilta osin tulevaisuustieteen teoriaan ja täydentää tietämystä teknologiakarttojen ja tuoteportfolioajattelun alueilta ja ehdottaa yritykselle käytettäväksi tuotekehitysprosessin mallia jolla tuotekehitystä voi harkita strategisella tasolla tulevaisuusteoriaa hyödyntäen.

Teoreettinen viitekehys tutkimukselle luodaan kattavalla kirjallisuustutkimuksella ja siitä saatua tietoa rikastetaan tutkijan pitkällä kokemuksella kyseessä olevalta liiketoiminta-alueelta, joka on rautatiekaluston alijärjestelmät. Metodologiset valinnat kerrotaan työn ensimmäisessä kappaleessa.

Tutkimuksen päälöydökset ovat, että yritys voi hyötyä monilla tavoilla siitä, että on tulevaisuuteen katsova tuotekehitysjärjestelmä, joka on nivottu strategiaprosessiin. Tutkija ehdottaa yritykselle strategiaprosessin mallia ja työkaluja joita voi käyttää, kun pohditaan tulevaisuuden tuotekehitys hankkeita ja ideoita.

Vaikka tuotekehityksen, teknologia-, tuote- ja innovaatioportfolioiden aihealueilta on paljon tutkimustietoa, on tarve vielä tutkia käyttöönoton esteitä mm. tulevaisuustietometodien ja ennustamisen tieteellisemmän lähestymistavan käyttöönoton osalta joka toimii pohjana tuotekehityspäätöksille.

Avainsanat Tuotesalkku, teknologia tiekartta, ennakointi, strategia

Sivut 114 sivua + liitteet 3 sivua

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Glossary

APAC	Asia-Pacific region
CIA	Cross impact analysis
ERRAC	European rail research advisory council
FRM	Future research methodology
HSR	High speed rail
OEM	Original equipment manufacturer
SBU	Strategic business unit
SME	Small and medium size business
CEM	Customer Experience Management
CRM	Customer Relationship Management

1 INTRODUCTION

To facilitate the organization for resources and focus on long term development of the product offering this thesis addresses some of the key issues of peripheral view to be used in conjunction with mapping the road ahead and developing an offering that would enable the company to remain the most wanted partner in the future. This thesis will present a process tool to be applied in the case company as a basis for an innovation program that is well informed by the future and utilizes the tacit knowledge in the company and the return of experience of the staff.

Figure 1 Thesis structure (Korhonen 2018)

The outline of this study is depicted in Figure 1 above. In this introductory Chapter 1 the objectives, main research questions, scope and limitations and methods are presented. In Chapter 2 the main literature concepts are presented. Chapter 3 features the tool selection for the case company

Chapter 4 includes the application of tools selected from the literature research applied on the case company market case study. Chapter 5 presents the strategy tool for the process of strategic leadership of product development in the case company. Chapter 6 opens the research path for follow-up and Chapter 7 presents the summary.

1.1 Objectives, research problem and delimitation

Objective of the research is to consider existing research in product management, road mapping and foresight theories and select the best applicable methodologies for the case company and develop a strategic management process that encompasses foresight, portfolio management and road mapping and facilitates product development that is market and technology driven.

The need for this research arises from the case company that does not have a formal process or methodology to address strategic innovation and product development in long term and take into account foresight.

Delimitation is depicted in the figure below. Clear exclusion in literature review is the strategic fit and strategy design areas which are well known in the company already. Also, innovation portfolio theory, not to be mixed with technology or product portfolios is excluded. Some of the key methodologies are also excluded because they are either well known in the case company management or not relevant to the market, size of the company or structure of the business unit.

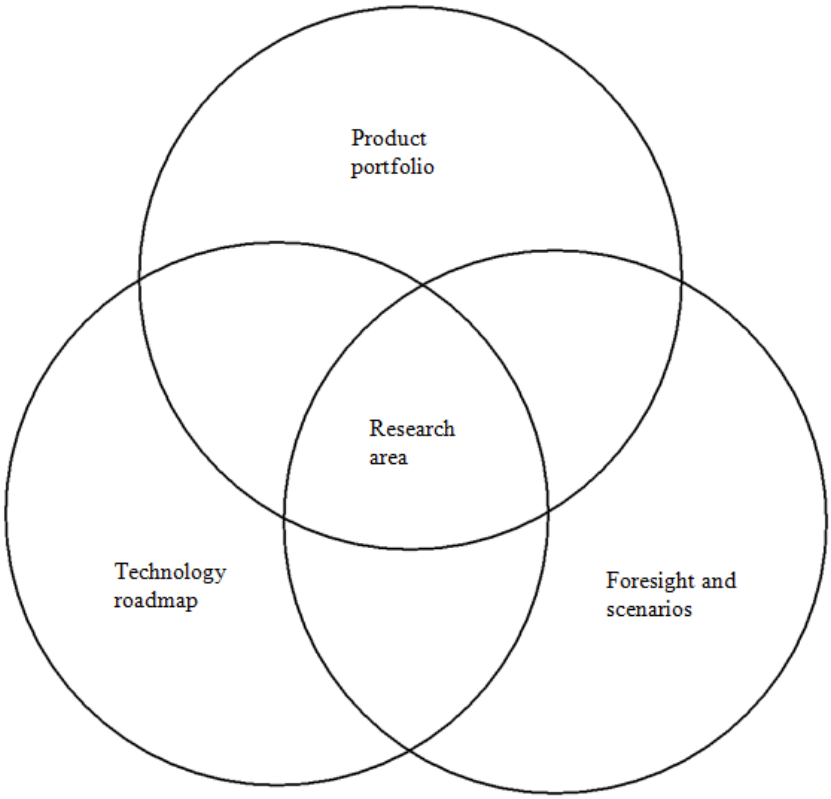


Figure 2 Research area (Korhonen, 2018)

Research question: Process for strategic leadership of product development in a case company

1.2 Research methods

The research question requires acquiring a large quantity of data and analysing it through the lens of experience gathered by the researcher while working in the industry for almost 15 years. For the research to be valid for the case company it must be understood that what is learned from experience extends beyond the strictures of formalized methodologies. The research philosophically leans towards an interpretative-hermeneutic paradigm because of its research methods which are theory oriented and therefore subjective in nature. However, through the application of the theoretical framework in the strategy of the case company the research ends up being in the realm of interpretative-experiential paradigm area. For collecting research data, the researcher shall use qualitative methods: participant observation, case study and team workshop. By combining these methods, the researcher should be able to have a strong base in theory supported by the practical approach to diminish the possibility of error, which might occur when using only one of the above-mentioned approaches. Furthermore, using a mixed method will provide more thorough empirical knowledge on the subject, which will in turn improve the quality of the study findings and suit the target organizations practical development needs better.

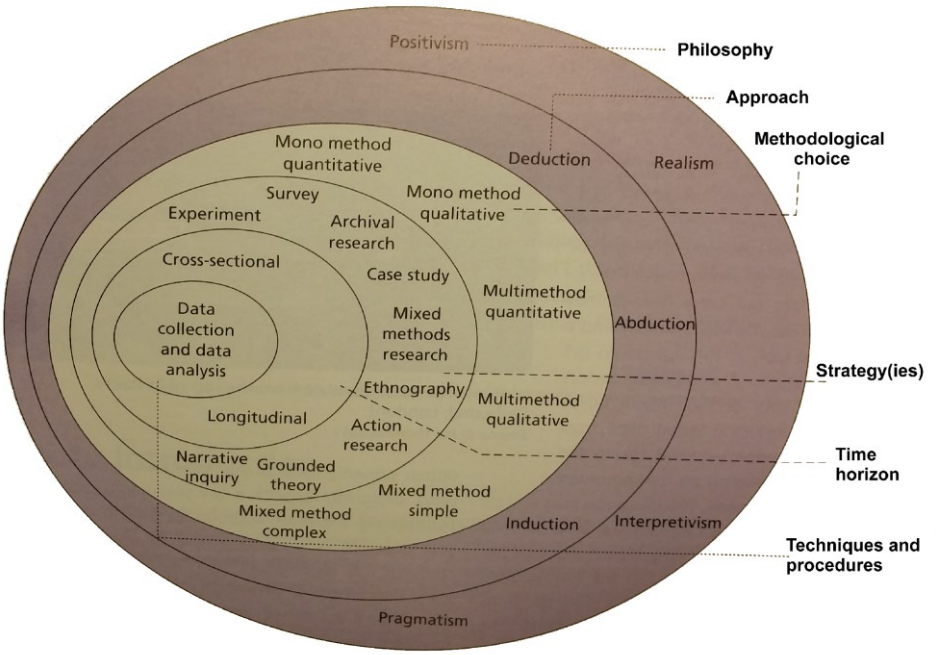


Figure 3 The research onion (Saunders et. al. 2012, 160)

Data collection is cross sectional giving a snapshot of the situation in the case company at a given time. With mixed methods of multi-methodological choice, using abduction on the raised material the researcher applies a realistic philosophy on the case company in attempt to solve the research question. Objective philosophy cannot be applied because it cannot be relied on that the claims, methods and results of science are not, or should not be influenced by perspectives, value commitments,

community bias in the case company. Quantitative methodology and statistical instruments cannot be used because there is no statistical data available and the multitude of factors that impact a case company business performance are not likely to offer the possibility for correlation analysis. For literature review the best journal, article and book sources are researched for the theoretical framework.

Philosophy of science	Subjective		Objective	
Paradigm	Interpretative-hermeneutical	Interpretative-experiental	Positivist-empirical	Critical-realistic
Theoretical approach	Abductive	Inductive	Deductive	
Methodology	Qualitative	Mixed methods		Quantitative
Methods	Case study, unstrutured workshop, participant observation		Action research, correlation etc.	
Time horizon	Cross sectional		Longitudinal	
Instruments, measurements	Questions, observations, theoretical frameworks		Statistical, mathematical etc.	

Figure 4 Theoretical positioning of the thesis (Korhonen 2016 adapted from Saunders et. al. 2012, Ramste 2015)

The researcher will conduct face-to-face unstructured workshop with employees working in different disciplines and having different work experience to have a view on the company`s market position and current product platform. One of the benefits of this method is that it provides a rich and deep conceptual content with the respondent's own words and reactions which is hard to achieve with any other methods. It allows the tacit knowledge to rise from the background and is not restricted by formal and exclusive interview techniques.

The starting point of qualitative research is to illustrate real life. It aims for a comprehensive approach so the reality cannot be broken into parts. Qualitative research allows the discovery of multidirectional relationships. It can be also stated that the aim is to discover and reveal things rather than prove them. (Hirsjärvi, Remes, Sajavaara 2000, 152)

To further extend on the selection of research methods it was clear from the beginning that the research must be as close to real life and result to actionable set of activities to be taken to retain or improve case company`s ability to compete with innovation. Because no statistical data exists how product development decisions have led to increased competitiveness in the case company and therefor objective philosophy not being able to apply it is deduced that with strong literature review giving the choice of methodologies selected and applied through the filter of return of experience existing in the organization of the case company gives the best combination in developing a forward-looking set of tools to manage the product portfolio of the company.

1.2.1 Case company

The business case group of companies is a large industrial conglomerate with more than 60000 employees working in many different fields of business from consumer goods to industrial solutions and from mass market products to tailor made customer specific solutions. On the group level the group does not steer the individual companies on strategies, products or any other key area but gives the SBU`s the possibility to develop their own areas and show the potential for growth and return on capital employed. The group is an industrial owner, not private equity with a strategy based on developing companies not on buying and selling them. It has a longer investment perspective and active ownership that aims for majority or 100% stake of the company. Historically the growth is double compared to long term Swedish industry average at OMX-Stockholm stock exchange. This approach creates a perfect opportunity of having a strong system for product development and clear innovation platform.

The case company SBU started as a spinoff and has been a separate business unit since 1999. It operates from Finland and exports 98% share of its products into approximately 20 countries globally. The workforce includes all industrial disciplines such as product development, design, sourcing, production, sales and after sales. The SBU has lots of cooperation with international suppliers, customers, accreditation authorities, testing & approval agents and service and overhaul companies. Product development is market driven and partially the scarcity of resources has not allowed the company to develop products in the long term for improved market position and efficiency in production.

The case company SBU operates in the area of components and systems for railway rolling stock. Railway rolling stock better known to public by the term “trains” is an investment heavy business area and global megatrends, investment climate and urbanization are important drivers to countries investing in this form of mass transport. The business used to be quite locally driven but nowadays the competition is global. A globalized playground places more demand for competing with product development that is radical in nature and should create more business opportunities than just the traditional market-pull incremental product development.

2 LITERATURE REVIEW, UNDERSTANDING FORESIGHT, TECHNOLOGY ROADMAPPING AND PRODUCT PORTFOLIO MANAGEMENT

Depiction of the limitation of research is shown in chapter 1.1. Given the trifold nature of the research the researcher has taken upon him to research three areas of theory all of which have a lot of published research in them and to come up with the most frequently referred tools. With this literature review the researcher should have a strong understanding of foresight and scenarios, product portfolio and technology roadmap tools that could be used together in defining the way of working for a technology based company in a practical and meaningful way in the innovation and product development process of

the company. The tools for the case company shall be selected later and literature review aims to research as many of them as possible to give the company a selection to choose from.

This Chapter has three main sections. The first section describes the findings of the literature review from the area of foresight and how it can serve a forward-looking company that is technology based and has product development needs. SWOT and PESTEL are brought in as a reminder of tools that are not exactly foresight tools but are often used to understand and discuss future challenges and are simple tools that are widely used in industry.

The second main section familiarizes the researcher with technology road mapping and product lifecycle management theory which forms the basis for building a product portfolio that is robust and tolerant to change.

The third main section researches product portfolio management theory which is an important factor in defining the case company product offering to the market and its positioning in competition against main rivals. While the customer needs are more and more market and purpose driven there needs to be a method for having a modular approach, a so-called product family, so that the company can have a wide product offering while retaining some technological similarities to produce the goods in an economical way.

2.1 Foresight and futures, background and tools in innovation

Foresight aims to sketch the picture of the future and it`s different alternative scenarios, in particular to prepare for the unexpected twists and turns in the business environment. Megatrends like globalization, technology evolution, but also superior customer centricity, networks and business cycles place pressure on organizations to cope with changes.

This chapter studies the definition of foresight, its history and which methods are available to apply foresight in a company and classifies them into qualitative and quantitative methods. SWOT and PESTEL are brought in as common tools in companies to understand and discuss the future although they are not officially futurological tools.

2.1.1 Definition of foresight

The term foresight was introduced by a Nobel price receiver Alfred North Whitehead in his book “Adventures of ideas”. In that book Whitehead (1933) states that forecasting “is faced with two sources of difficulty where science is faced with only one. Science seeks the laws only where foresight requires in addition due emphasis on the relevant facts from which the future is to emerge” (Whitehead 1933, 88).

Foresight is often confused with prediction. The whole point in foresight is to help shape the future by anticipation and foreseeing the variety of possible futures and working to creating the desirable future through actions today.

”*Chance favours the prepared mind*” - Louis Pasteur

“*It`s not the strongest of the species who survive, nor the most intelligent, but the ones most responsive to change.”*- Charles Darwin

Foresight has many definitions but one often cited is Richard Slaughters one stating it is the ability to create and maintain a high-quality, coherent and functional forward view and the use of insights arising in organizationally useful ways, for example, to detect adverse conditions, guide policy and shape strategy and to explore new markets, products and services (Slaughter, 1999)

The idea of foresight is built on the assumptions that several different futures are possible and the future is unpredictable and uncertain. However, the change drivers can be studied and identified and the future can be influenced if not changed by those who act on it early enough.

Corporate foresight is the ability that permits as organization to lay the foundation for future competitive advantage. This ability is based on identifying, observing and interpreting factors that include change, determining possible organization-specific implications and triggering appropriate organizational responses. (Rohrbeck et. al. 2015, Georghiou, 1996, Martin 1995)

A definition more focused on technology foresight is provided by Barré (2001 in Georghiou et. Al. 2008, 13) where foresight is seen as a decision support process with the following characteristics:

- Long term perspective
- Particular focus on changes
- Interactivity among participants
- Transparency, openness
- Appropriation of the process to the actors and stakeholders
- Diversity of actors and inputs
- Interest in the Science and technology
- Concern for alternatives, identification and exploration of hypothesis
- Strategy formation

To explore the impact of corporate foresight on the innovation capacity Rohrbeck & Gemunden collected empirical evidence from 19 multinational companies. Of a total of 107 interviews, 42 were conducted with internal stakeholders, generating insight into how foresight results are used within the company. The three roles of corporate foresight in innovation management were

- In the initiator role, corporate foresight triggers innovation initiatives by identifying new customer needs, technologies, and product concepts of competitors.
- In the strategist role, corporate foresight directs innovation activities by creating a vision, providing strategic guidance, consolidating opin-

ions, assessing and repositioning innovation portfolios, and identifying the new business models of competitors.
– In the opponent role, corporate foresight challenges the innovators to create better and more successful innovations by challenging basic assumptions, challenging the state-of-the-art of current R & D projects, and scanning for disruptions that could endanger current and future innovations. (Rohrbeck & Gemunden 2011, 237)

Foresight is the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefit.

The traditional linear strategic planning methods (Ansoff 1965; Minzberg, Lampel 1999) are concentrating on an efficient, well-focused strategic plan with a clearly defined vision, mission and strategy statements. The side effect of this may be that a strong strategy process is reducing the peripheral view for surprising shifts in the business environment. In order to avoid strategic surprises, the strategy process should be able to open the scope of observation for periphery incidents and early warning signs.

2.1.2 History of foresight

Future studies take its roots from science fiction authors and their future visions. After the Second World War think tanks such as RAND emerged providing research and strategy services to US military. Such organizations became high status centres of multidisciplinary research where scientists could work in a cross disciplinary way considering wide range of political, social and technological issues. Many of the familiar tools of modern Future studies were nurtured in this context. Herman Kahn was one of the better-known figures with his scenarios for the year 2000 made in the 60`s and 70`s. He presented scenario analyses, extrapolation and Delphi results.

Corporate foresight emerged as a research area in the 1950`s. The area had 2 main roots the first of which was the French prospective school founded by Gaston Berger. The second was the foresight school based in the work of Herman Kahn and the RAND Corporation.

The main initial Delphi work was performed at the RAND Corporation, in the years following 1948, the pioneers being Kaplan, Helmer and Rescher and Dalkey. Forecasting, as it was known then, was motivated by Bush's book Science, The Endless Frontier, advocating the transformation of the U.S. military economy R&D during World War II (for instance the Manhattan Project) into long-term civil research and commercial exploitation. (Grupp, Linstone 1999, 88)

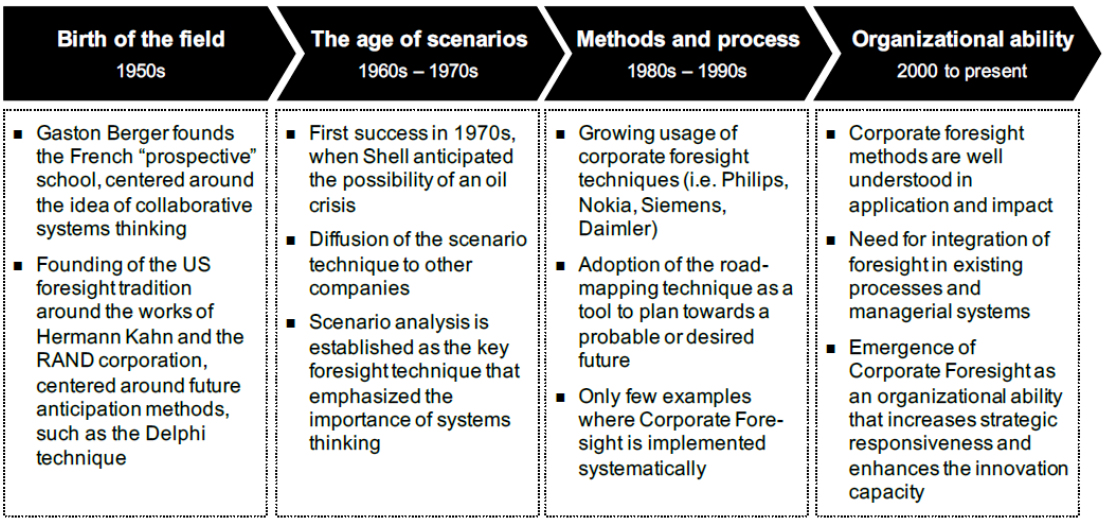


Figure 5 Development of the corporate foresight research team (Rohrbeck et. al. 2015)

The 1960`s saw an upsurge of futures studies in Europe in UK and France. It often drew on US studies placing less emphasis on technological change and being more open to alternatives, able to consider qualitative and structural changes as well as quantitative and continuous evolution. One of the contributions of Michel Godet in the turn of the millennium was that he saw a "strategic prospective" as a management tool enabling anticipation to be linked to action.

Technology assessment began to develop in the 1970`s and took root in a number of countries – notably Denmark, Germany and the Neatherlands and have continued to evolve as an input to decision making (see e.g. Rip et al. 1995, Vig and Paschen, 2000)

Limits to Growth published in 1972, was the first report of the Club of Rome. The book, which sold over ten million copies in various languages, was one of the earliest scholarly works to recognize that the world was fast approaching its sustainable limits. Over forty years later, the planet continues to face many of the same economic, social, and environmental challenges as when the book was first published. The report followed by the book gave the first joint effort results from a group consisting of statesmen and the science community in the area of forecasting and scenarios. It gave scenarios to some of the phenomenon and modelled trends of 5 interrelated phenomena into the future – industrialization, population growth, malnutrition/food, depletion of non-renewable resources and deteriorating environment as the biggest "predicament of mankind". The work failed to see technological progress and the efficiency increase in food production that has increased the carrying capacity to the level that can be considered sustainable level. It also somewhat underestimated ability to change behaviour in response to scarcity and higher prices of resources. As *The Limits to Growth* pointed out almost 50 years ago, one of the best indications of wealthy human population is the amount of resources consumed per person (Meadows et. al. 1972, 107). That statement is even truer now than it was in 1972.

Limits to growth`s inability to see technological progress and the efficiency increase as a vehicle to future is today understood better and forecasting and scenarios of top level phenomenon like population growth are linked directly to infrastructure planning in e.g. train tracks, stations, roads which then contributes to building and manufacturing opportunities for companies working in that technology area.

2.1.3 Is foresight a tool for innovation?

How can foresight activities help identify new business opportunities:

- To introduce tools methods and processes throughout the organization besides the designers
- To analyse foresight knowledge and integrate it into decision making
- To link activities to benefit customers businesses
- Concrete benefits to strategy work

In a rapidly changing environment the biggest competitive threat is the steady pace of competence-destroying change that occurs, combined with the inability of management to foresee these changes. (D'Aveni 1994, Eisenhardt& Brown 1998, Brown& Eisenhart 1998)

To navigate turbulent business environments, organizations have to develop foresight capacities that enable them to anticipate probable futures, respond rapidly to emerging changes, and support future oriented action. (Graefe, Luckner, Weinhardt 2010, 394)

Rohrbeck et. al. (2009, 32) benchmarking study on Strategic Foresight in multinational companies conducted by the Chair for Technology and Innovation Management at the Technische Universtität Berlin, Deutsche Telekom Laboratories (T-Labs) and the European Center for Information and Communication Technologies (EICT GmbH) indicate that companies have built strong capabilities for collecting information. However, their ability to interpret information, disseminate gained insights and trigger management reactions leaves room for improvement. The comparison of top performing companies with all participating companies shows that top performers

- invest significantly more resources in gathering data from restricted sources,
- utilize more qualitative methods, and
- more often select methods deliberately
- engage in more bottom-up triggered foresight activities, which should raise the overall level of alertness as well as their scanning reach and scope.

According to Heinonen (2010), anticipation is also well suited for searching and quest for innovation. A foresight process in companies should be

connected to strategy work as well as in the innovation processes. Foresight can be considered as preparation for the future. (Heinonen 2010, 77).

The keys to improving firm`s foresight activities

- Widening the perception filter: an extensive map of promising future technologies
- Deepening the mentality filters: how main challenges and customer needs are met with the technologies
- Improving the power filter: how to empower best innovators; who are key customers
- and how to meet their needs. (Kuusi 2006, 5)

Technology foresight was seen as a necessary element to build informed research policies and started to intervene systems that were marked as complex and interdependent. From the very beginning the Japanese decision makers had woven foresight processes most notably Delphi surveys within the networks of academics, industrialists, policy-makers and entrepreneurs.

Hugh Courtney (2011) has also classified how to make sense of the 4 different levels of uncertainty.

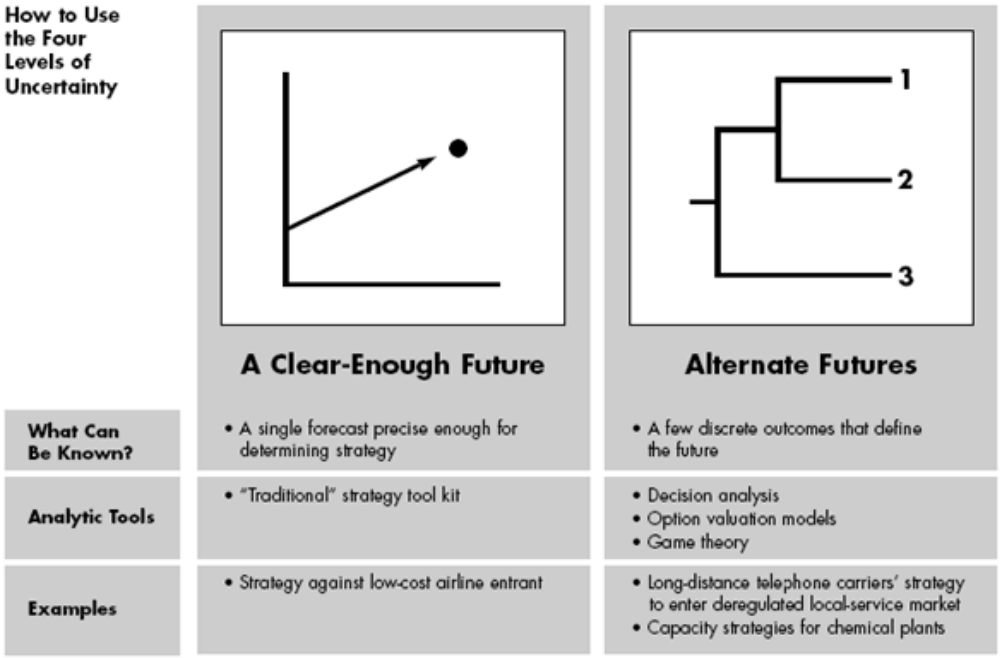


Figure 6 Four levels of residual uncertainty 1-2/4 (Courtney 2011, 22)

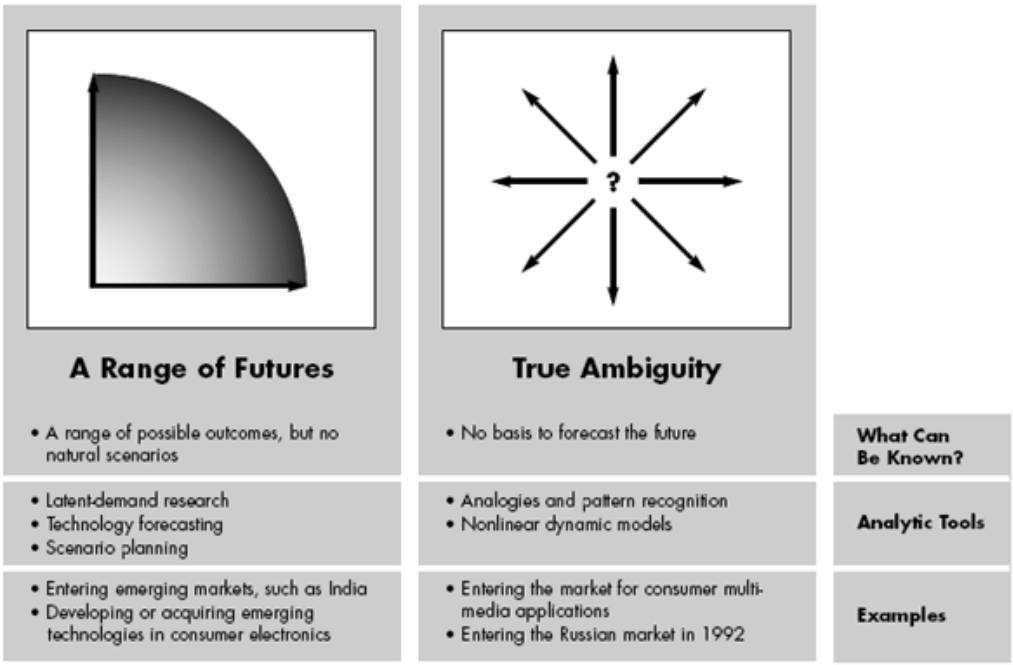


Figure 7 Four levels of residual uncertainty 3-4/4 (Courtney 2011, 22)

In figure 4 left a clear enough future model exists on a stable market where external shock effects are not expected. Alternative futures model is to a degree more unstable. Some alternative futures can be foreseen and probable futures are limited to a few likely ones.

In figure 5 left a range of futures model is where one can forecast only variation ranges but not the amount of possible alternative futures. In a true ambiguity situation there are a lot of uncertainties and great deal of factors contributing to it.

One can deduce that the solution to level 1 uncertainty (clear enough) is to use trend analysis and plot the future. For level 2 and 3 a company could use scenario analysis. Sources for level 2 and 3 could be e.g. customer demand, relative performance of a technology and customer preference for new competing technologies or business models. Weak signals analysis is suitable in level 4 situation where true ambiguity exists.

2.1.4 Methodologies available for foresight

There are at least 40 tools for foresight and only some of them are described in the next 2 chapters. Their applicability is strongly related to the industry or environment on which the tools are applied. The researcher has gathered some of the better-known tools and ones that are more relevant to the research subject and case company.

In Poppers **S.M.A.R.T. Futures Jigsaw** seven elements help to map practices and relate to the scoping futures phase of a foresight or horizon scanning process, another seven elements help to map players and relate to the mobilising futures phase of the Foresight activity. Overall, nineteen elements can be used to map outcomes

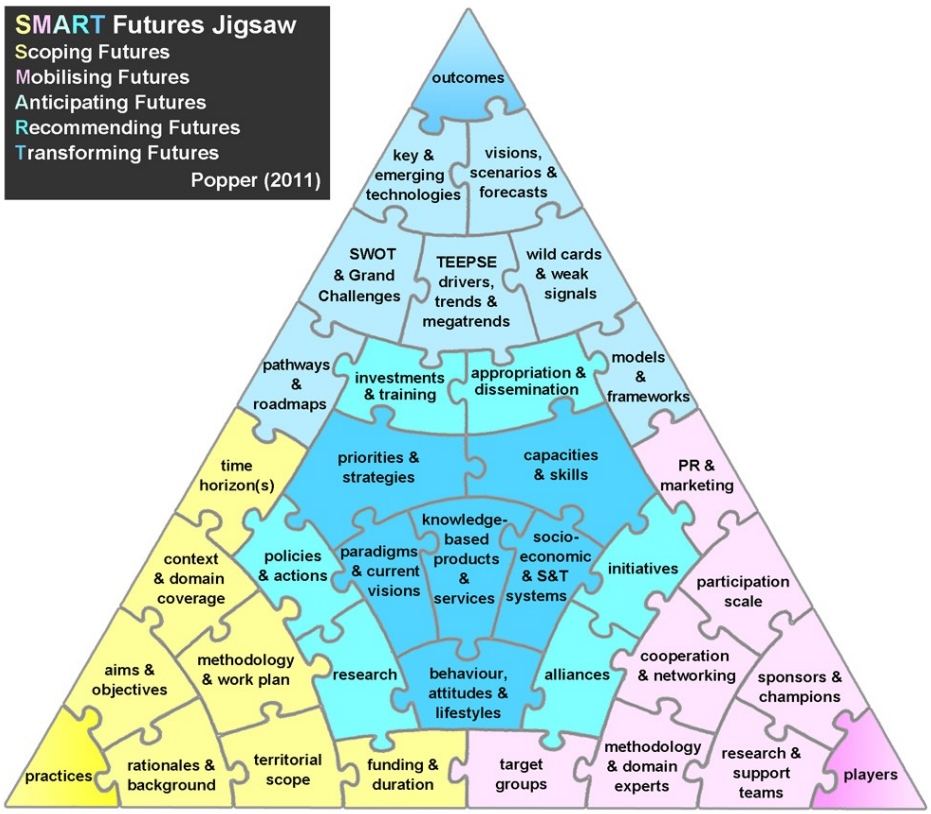


Figure 8 The SMART Futures Jigsaw (Popper, 2011)

Regarding foresight methodology Rafael Popper (Georghiou et. Al. 2008, 44) points out that although some popular methods like Delphi, scenarios, SWOT and road mapping have attracted many articles many of them fail to compare methods systematically. Slaughter (2004 in Georghiou et. al. 2008, 44) denotes that it is the depth within the practitioner that evokes depth and capacity in whatever method is used.

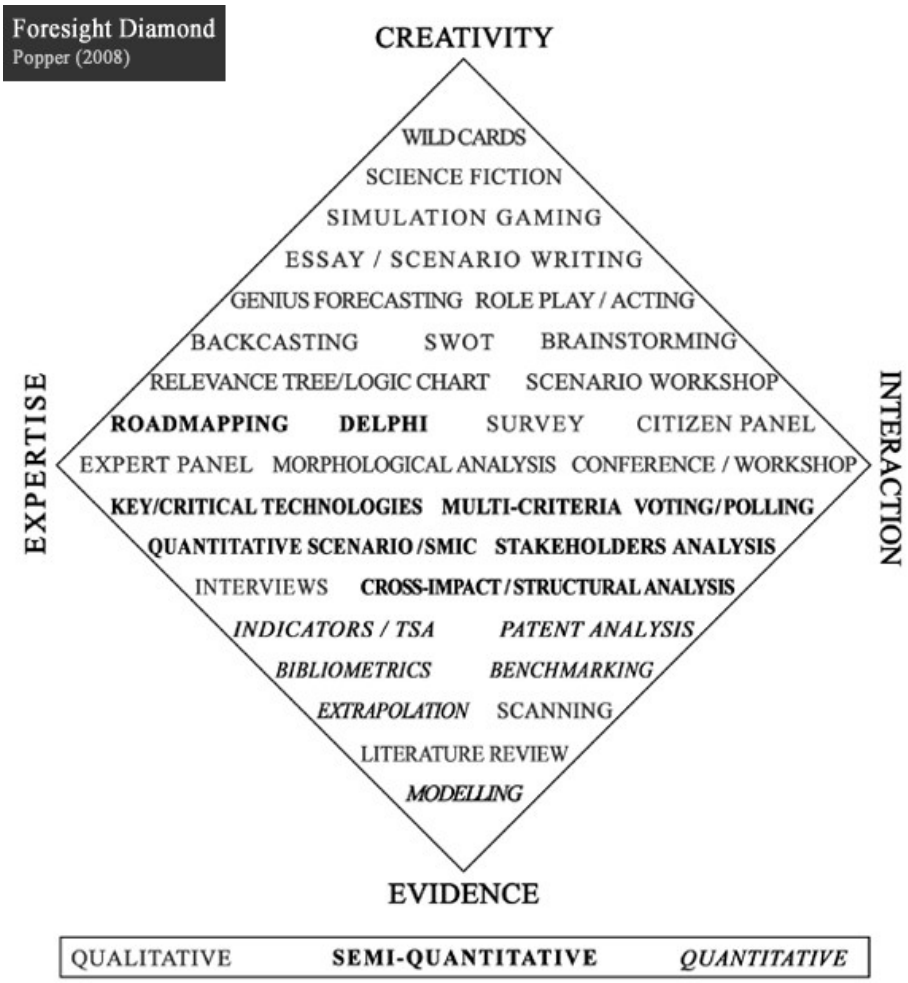


Figure 9 The foresight diamond (Popper in Georghiou et. Al. 2008, 71)

The foresight diamond helps in selecting the methods used in a foresight process. A comprehensive foresight process should utilize at least one method from each pole. Different font types explain the nature of each method in the scale of quantitative to qualitative.

The Millennium (2015) project has listed a number of future research methods (FRM) and keeps updating the list of relevant methods on their website. The latest update is from 2009. Only 11 methods match Poppers list in the foresight diamond on the title level. The matching methods are coloured blue and written in *Italics* font.

Table 1 Futures Research Methodology Version 3.0 (Spring 2009)

1. Introduction to the Futures Research
1.5 Evaluation and organization of Methods
2. *Environmental Scanning*
3. *The Delphi Method*
4. Real-Time Delphi
5. The Futures Wheel
6. The Futures Polygon
21. Participatory Methods
22. *Simulation and Games*
23. *Genius Forecasting and Intuition*
24. Visioning for Strategic Planning
25. Normative Forecasting
26. TRIZ
27. *S&T Road Mapping*

7. Trend Impact Analysis
8. *Cross-Impact Analysis*
9. *Wild Cards*
10. *Structural Analysis*
11. The Systems Perspectives
12. Decision Modeling
13. Substitution Analysis
14. Statistical Modeling
15. Technology Sequence
16. *Morphological Analysis*
17. *Relevance Trees*
18. *Scenarios*
19. Interactive Scenarios (software)
20. Robust Decisionmaking
28. Field Anomaly Relaxation (FAR)
29. Text Mining for Technology Foresight
30. Agent Modeling (demo software)
31. Prediction Markets
32. Forecasting By Artificial Neural Networks
33. State of the Future Index
34. SOFI Software System
35. Multiple Perspective Concept
36. A Toolbox for Scenario Planning
37. Heuristics Modeling
38. Personal Futures
39. Causal Layered Analysis
40. Linking Methods
41. Integration, Comparisons, and Frontiers

Aaltonen and Barth have commented on the methods of the previous version 2.0 (2003) of the methods list making an effort to classify the methods based on means of controlling a system under forecast and the nature of the system to be understood.

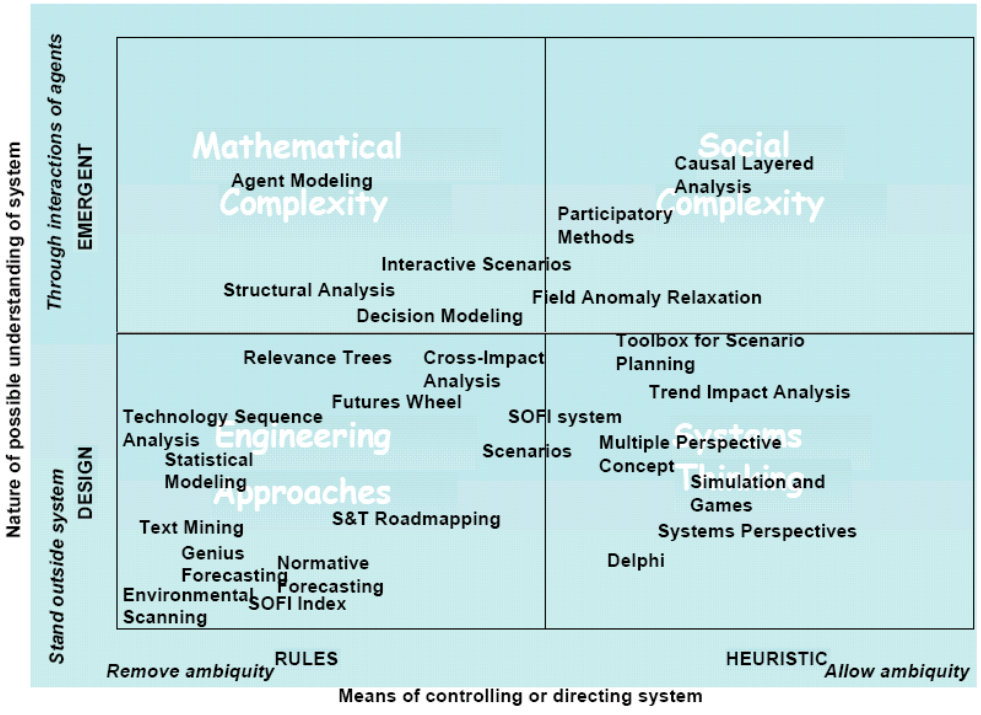


Figure 10 The embedded attributes of the methods in "Futures Research Methodology – V2.0" (Aaltonen& Barth 2005, 49)

Glenn and Gordon (2003) classified the taxonomy of FRM futures research methodologies in quantitative, qualitative, normative and exploratory classes.

Method	Quantitative	Qualitative	Normative	Exploratory
Environmental scanning		X		X
Delphi		X	X	X
Futures wheel		X	X	X
Trend impact analysis	X			X
Cross-impact analysis	X			X
Structural analysis	X	X		X
Systems perspectives	X			X
Decision modeling	X			X
Statistical modeling	X			X
Technology sequence analysis		X	X	
Relevance trees and morphological analysis		X	X	
Scenarios	X	X	X	X
Interactive scenarios		X	X	X
Participatory methods		X	X	
Simulation and games		X		X
Genius forecasting, vision, intuition		X	X	X
S&T road-mapping		X	X	X
Field anomaly relaxation		X		X
Text mining		X	X	X
Agent modeling		X		X
SOFI index	X	X	X	X
Multiple perspective concept		X	X	X
Causal layered analysis		X		X

Figure 11 Taxonomy of FRM futures research methodology V2.0 (Glenn, Gordon 2003)

Aaltonen`s and Barth`s analysis explains that most of the methods presented in FRM are designed to remove ambiguity and they concentrate on knowing, or to be more precise, on removing ambiguity from the decision-making process. Most of methods are also used outside the system to bring new information inside the system. Other types of frequently used methods are those that seek to create awareness of possible futures, and about things they convey. The embedded conception of causality, of how things happen, is that there is an agent, capable of finding out the causalities and able to design interventions that lead to a desirable future (Aaltonen& Barth 2005).

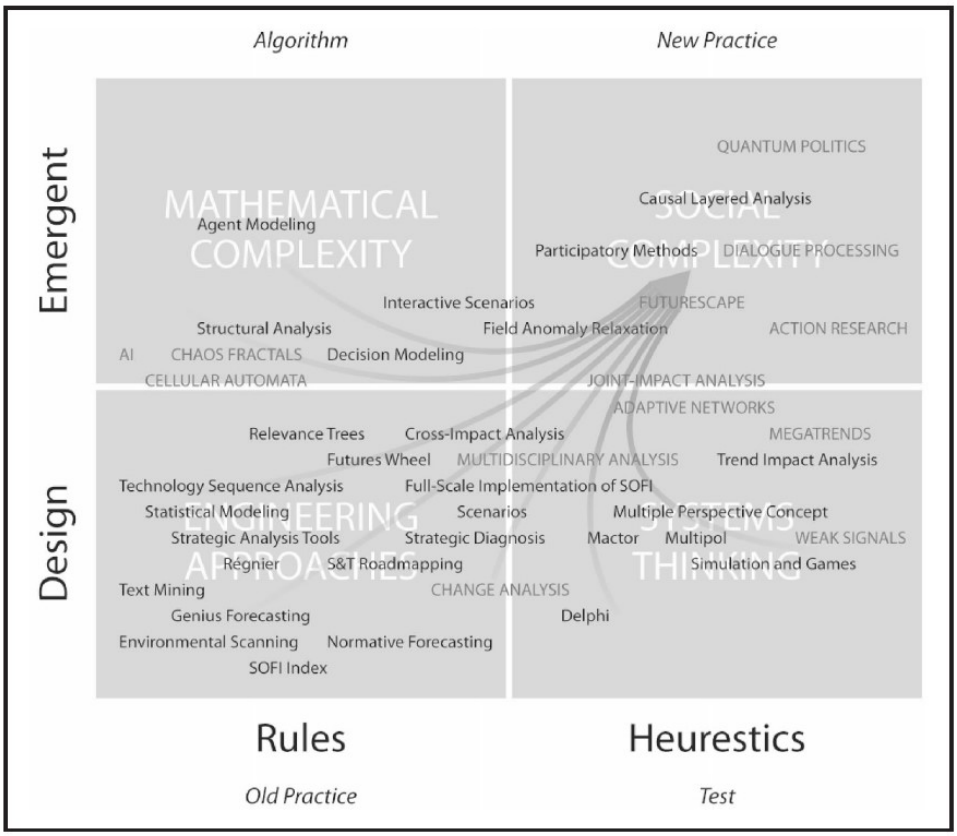


Figure 12 Futures research methodology with complex systems concepts – tools map (Aaltonen&Sanders, 2006, 33)

In Aaltonen and Sanders (2006) work they concluded that the three domains of engineering approaches, systems thinking and mathematical complexity are the starting points not the finishing points of a foresight exercise. They propose that every exercise should collect and create as much information from all the necessary sources and the finish with a method that stands in the social complexity domain which allows the emergence of nonlinear development and new practices. (Aaltonen&Sanders 2006, 33)

Magruk (2011) in his research have classified technology foresight methods. He finds that the overall choice of methods should be subordinated to research objectives. When it comes to technology foresight research issues should be considered the problem (Magruk 2011, 712).

After listing the foresight research methods Magruk classifies them in innovative classes.

Innovative classes	Methods belonging to each class
Consultative	Voting, Polling, Survey, Interviews, Expert Panels, Essays, Conferences, Workshops, Citizen Panels, Brainstorming
Creative	Wild Cards, Weak Signals, Mindmapping, Lateral Thinking, Futures Wheel, Role Play, Business Wargaming, Synectics, Speculative Writing, Visualization, Metaphors, Assumption Reversal
Prescriptive	Relevance Trees, Morphological Analysis, Rich Pictures, Divergence Mapping, Coates and Jarratt, Future Mapping, Backcasting, SRI Matrix, Science Fiction Analysis, Incasting, Genius Forecasting, Futures Biographies, TRIZ, Future History, Alternative History
Multicriterial	Key Technologies, Source Data Analysis, Migration Anal., Shift-Share Anal., DEA, Factor Anal., Correspondence Anal., Cluster Anal., Sensitivity Anal., AHP, Input-Output Anal., Priorization, SMART, PRIME, MCDM
Radar	Scientometrics, Webometrics, Patent Analysis, Bibliometrics, Technological Substitution, S-Curve Anal Technology Mapping, Analogies
Simulation	Probability Trees, Trend Extrapolation, Long Wave Anal., Indicators, Stochastic Forecast, Classification Trees, Modeling and Simulation, System Dynamics, Agent Modeling
Diagnostic	Object Simulation, Force Field Anal., Word Diamond, SWOT, STEEPVL, Institutional Anal., DEGEST, Trial&Error, Requirement Anal., Theory of Constraint, Issue Management, ANKOT
Analytical	SOFI, Stakeholder Anal., Cross-Impact Anal., Trend Impact Anal., Structural Anal., Megatrend Anal., Critical Influence Anal., Tech. Barometer, Cost-Benefit Anal., Technology Scouting, Technology Watch, Sustainability Anal., Environmental Scanning, Content Analysis, FMEA, Risk Anal., Benchmarking
Survey	Web Research, Desk Research, Tech. Assessment, Social Network Anal., Literature Review, Retrospective Analysis, Macrohistory, Back-View Mirror Analysis
Strategic	Technology Roadmapping, Tech. Positioning, Delphi, Scenarios, Social Impact Assessment, RPM, Technological Scanning, Multiple Perspectives Assessment, Causal Layered Analysis, MANOA, Action Learning

Figure 13 Classification of technology foresight research methods (Magruk 2011, 710)

The last tenth cluster is formed by strategic methods designing and analyzing complex objects. This class consists of evidence based cognitive insightful methods relating to the future of the object being analyzed. In the methods discussed in the future image is divided into more detailed elements. The methods of this group are helpful in planning, scenario building, decision making in solving complex decision problems and challenge management. (Magruk 2011, 711)

A deep and broad understanding of methods and their qualities is the starting point for successful foresight. No single method should be trusted; an insightful combination of various, even contradictory methods can create foresight. (Aaltonen&Sanders 2006, 34)

2.1.5 Taxonomy of foresight methods based on data (quantitative)

Trend extrapolation is a forecasting technique which uses statistical methods (such as exponential smoothing or moving averages) to project the future pattern of a time series data (Business dictionary, 2015)

Trend Extrapolation/Impact Analysis are among the longest-established tools of forecasting. They provide a rough idea of how past and present developments may look like in the future – assuming, to some extent, that the future is a kind of continuation of the past. Recently, the concept of Megatrends has become popular to refer to macro level phenomena which include various sometimes conflicting sub-phenomena (e.g. globalization,

ageing, climate change). On the other hand, Impact Analysis aims to identify potential impacts that major trends or events would have on systems, regions, policies, people, etc. (Popper 2008)

It is generally accepted that there are different trends, the most important of which are shown schematically in the figure below

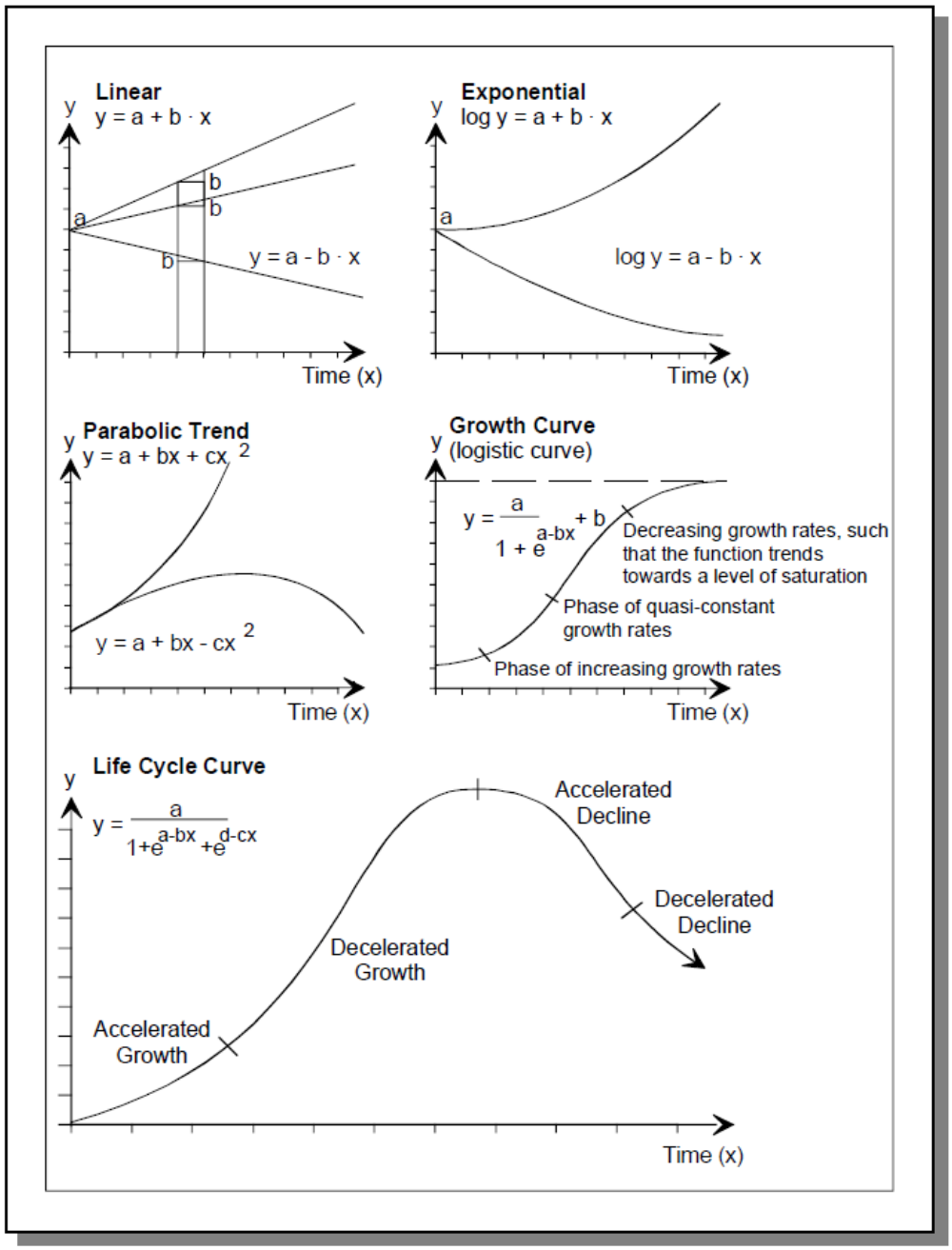


Figure 14 Statistic Curves

Time series analysis, comprises methods for analysing time series data in order to extract meaningful statistics and other characteristics of the data. Time series forecasting is the use of a model to predict future values based on previously observed values (Mellin 1996, 217). The method assumes that 'inherent laws' are effective during the course of economic activity and steer the development of economically relevant variables onto certain

predestined courses. This leads to the conclusion that, once these laws are successfully quantified through analysis of past developments and expressed in the form of an appropriate formula, one can then automatically also be in a position of being able to visualize future development. Forecasts based on such basic concepts are essentially built on an analysis of past activity. The results of this analysis are considered valid also in future by means of an analogy conclusion. Examples of time series trends are linear, exponential and parabolic trends, logistic curve and life cycle curve.

Regression analysis (taking into account the combined effects of several factors on the selected variable), is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning. Regression analysis is a mathematical measure of the average relationship between two or more variables in terms of the original units of the data (Gupta & Kapoor 2002, 10-49). Regression analysis entered the social sciences in the 1870s with the pioneering work by Francis Galton, but ‘‘least squares’’ goes back to at least the early 1800s and the German mathematician Karl Gauss, who used the technique for predicting astronomical phenomena (Armstrong 2012, 689).

In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. However this can lead to illusions or false relationships, so caution is advisable; *for example, correlation does not imply causation* (Armstrong 2012, 693).

The simplest linear regression model involves only one independent variable and states that the true mean of the dependent variable changes at a constant rate as the value of the independent variable increases or decreases. Thus, the functional relationship between the true mean of is the equation of a straight line. Regression analysis may be one of the most frequently used tools in market research. In its simplest form, regression analysis helps analyse relationships between one independent and one dependent variable. In marketing applications, the dependent variable is usually the outcome we care about e.g. sales, while the independent variables are the instruments we have in use e.g. pricing or advertising, to achieve those results with. Regression analysis can provide insights that few other techniques can. The key benefits of using regression analysis are that it can:

- Indicate if independent variables have a significant relationship with a dependent variable.
- Indicate the relative strength of different independent variables’ effects on a dependent variable.

Cross analysis (forming images of the future by making combinations of variables that are attached with values and often also probabilities), is a methodology developed by Theodore Gordon and Olaf Helmer in 1966 with the game "Futures" created for the Kaiser Corporation to help determine how relationships between events would impact resulting events and reduce uncertainty in the future.

The Central Intelligence Agency became interested in the methodology in the late 1960s and early 1970s as an analytic technique for predicting how different factors and variables would impact future decisions. In the mid-1970s, futurists began to use the methodology in larger numbers as a means to predict the probability of specific events and determine how related events impacted one another.
Since then, several versions of cross impact analysis have been developed by researchers. These can be classified into three groups: quantitative, qualitative, and mixed CIA. In quantitative CIA, a mathematical model relating to the variables is constructed, while in qualitative CIA, experts are asked to provide subjective estimates of the relationships among the variables, usually in the form of a matrix of conditional probabilities or impact values. In this study, a qualitative CIA based on the structural analysis proposed by Duperrin and Godet is adapted (Asan & Asan 2007, 628). Early references to *futurists* discussing the methodology are e.g. Norman Dalkey and Murray Turoff in 1972.

Cross-impact analysis provides a systematic way to examine possible future developments and their interactions. Thus, a cross-impact analysis is concerned with the identification of possible outcomes rather than with an understanding of what is or what was. It differs in this way from both probability theory and mathematical statistics. (Enzer & Alter 1978, 227) In cross-impact analysis, one is concerned about the probability that *A* **will** happen **if** *B* happens first. In classical probability, one asks for the probability that *A* **has** happened conditional on the fact that *B* **has** happened. (Enzer & Alter 1978, 238)

Cross-impact analysis seems to have two schools of thought and ways of approach. The first is the futures forecasting style that originally developed the methodology. The second is a sub-school of intelligence analysts which modified the original methodology to better address their needs. That school of thought takes into account the interactions among events, evaluating changes in the probability of occurrence of an event (individual probability) when other events "do or do not occur" (conditional probability). The individual and conditional probabilities used in the CIA method are obtained by asking a group of experts about the future occurrence of the events analyzed. One could say that this method is more qualitative than quantitative.

Nevertheless, Cross Impact Analysis is based upon the idea that events and activities do not happen without outside influence, other events and the surrounding environment can have a significant impact on the probability of certain events to occur.
Well-known for many years, the Cross-Impact analysis is a family of methods that has been developed into many variants to generate rough scenarios for complex, but weakly structured systems. Its approach is based on the evaluation of interrelations between the most important influential factors in a system by experts who evaluate pairs of these factors (for example as conditional probabilities), and then to find out which scenarios are probable in view of the established network of interrelations with the help of suitable mathematical procedures. The fact that this meth-

od is based on expert judgments makes it possible to use it also for weakly structured problems; on the other hand, the results depend fundamentally on the involved experts' ability to evaluate the system and the relations between its elements. The first approaches to Cross-Impact analysis were developed in the 1960s in response to a shortcoming of Delphi surveys. In these, experts were asked about the future chances of different technologies, but the mutual influence existing between the technologies was not taken into account. Gordon and Hayward therefore introduced a concept in 1968 saying that the occurrence of an event (for example the realization of a technology) modifies the occurrence probability of other events. (Weimer-Jehle 2004, 336)

Simulations (for example limits to growth). The original version of limits to growth presented a model based on five variables: world population, industrialization, pollution, food production and resources depletion. These variables are considered to grow exponentially, while the ability of technology to increase resources availability is only linear. (Meadows et. al. 1972)
In service business for example growth of the activity will lead to a reduction of demand, based on saturation in customer value creation and willingness to pay. That represents a limit to growth (demand limit) that could be simulated by e.g. Porter five forces model.

Simulations can be complimentary to forecasting assuming that forecasts in the long term are not possible because of inherent uncertainties that cannot be quantified. This is because general conditions change, not only for company economies but e.g. for foreign trade, in ways that cannot be assessed objectively via probability or plausibility considerations. Therefore, it is necessary to consider alternatives, i.e., to simulate various equally likely future scenarios – mostly with a view to their economic effects. The variables must be predicted by means of judgments based on estimates before it is possible to start working on the actual forecast.

Benchmarking is a method commonly used for marketing, business strategy planning and production and has recently become more popular in governmental and inter-governmental strategic decision-making processes. The main question here is what others are doing in comparison to what you are doing. Benchmarking as a concept was coined by Robert C. Camp when he was working at Xerox in the 1980`s in United States. Camps first and the best-known book came out in 1989 and was named The Search for Industry Best Practices That Lead to Superior Performance. Camp subsequently wrote two more books on the subject.

Patent Analysis often resembles bibliometrics, but uses patents rather than publications as its starting point. Quantitative analysis utilises statistical methods to look at the number of patent registrations, assuming that increasing or decreasing registrations would (apparently) indicate, for example, low or high potential for technology developments in a specific area. More qualitative analyses may focus more on the contents of the patents. (Popper 2008)

If it suits the business area that is in rapid development phase patent analyses can give easily and quickly an overall understanding of the area, as well as information on industry trends. By analysing patents in the field of technology research can find the technology leaders and trends in the industry. Analysis of competitors' patents can determine annual changes in research activity, the research group's scopes, partners and planned markets. By mere queries and those printed on patent documents it would be difficult, if not impossible, to obtain this information by reading. The analysed data is valuable in strategic planning and competitor monitoring tool, but it is also beneficial for persons engaged in the R & D area.

2.1.6 Taxonomy of foresight methods based on expert knowledge

Environmental scanning involves observation, examination, monitoring and systematic description of the technological, socio-cultural, political, ecological and/or economic contexts of the company. There is a difference between active and passive scanning. All managers scan, but they often do so passively. They keep their antennae up and wait to receive outside signals. Environmental scanning is a term coined in the mid-1960's by Francis Aguilar, a Harvard Business School professor, to describe the action of watching and collecting information on a company's rivals and the overall market. In the framework of technological foresight and product development the view on environmental scanning is more the external view i.e. environmental scanning as information seeking. A company should strive for objective reality and create organizational learning by analyzing the micro environment by competitor analysis with e.g. Porter five forces and by analyzing the macro environment by e.g. PESTEL-analysis.

Because most of the data comes from familiar or traditional sources, environmental scanning tends to reinforce, rather than challenge prevailing beliefs. Active scanning reflects intense curiosity and emphasizes the further-out and fuzzier edge of the periphery. (Day& Schoemaker 2006; Kaivo-oja Jari 2012, 210)

All scanning systems – either conscious or unconscious – have some filters (Ansoff 1979, 157).

Delphi, method belongs to the subjective-intuitive methods of foresight. Delphi was developed in the 1950's by the Rand Corporation, Santa Monica, California, in operations research. The name can be traced back to the Delphic oracle and that the name 'Delphi' was intentionally assigned by Kaplan, an associate professor of philosophy at the UCLA working for the RAND-corporation in a research effort directed at improving the use of expert predictions in policy-making. (Kaplan et al. 1950)

Delphi is an analytic technique that gathers a group of experts on a subject together and asks their opinion on a scenario or prediction. Usually, analysts consider the average prediction or scenario as the most likely to occur. This approach consists of structural surveys and makes use of the intuitive available information of the participants, who are mainly experts, conducted in two or more rounds and provides the participants in the sec-

ond round with the results of the first so that they can alter the original assessments if they want to - or stick to their previous opinion. Nobody 'loses face' because the survey is done anonymously using a questionnaire. The Delphi method is especially useful for long-range forecasting (>20 years), as expert opinions are the only source of information available.

Delphi can be described as a method of eliciting and refining group judgement (Dalkey 1969) or as an interview or questionnaire type of research method that utilizes a structured process of exploration of expert knowledge in the research area or phenomenon (Linstone&Turoff 2002; Linturi 2007)

Weak signals as a term have many explanations and definitions. Strategy guru Igor Ansoff defined his in the 1970`s so that weak signals are "company internal or external warning signs, events or developments that are too weak so that their impact could be evaluated". Similarly, Schoemaker and Day (2009) see a weak signal as ''a seemingly random or disconnected piece of information that at first appears to be background noise but can be recognized as part of a significant pattern by viewing it through a different frame or connecting it with other pieces of information''. (Korhonen 2014, 55)

When the weak signal is new and it is inconsistent with the manager's past experience it is easily rejected as inaccurate or irrelevant. Weak signals that do not fit are often ignored, distorted or dismissed, leaving the company exposed (Schoemaker& Day 2009, 88). Managers' inability to foresee changes that might destroy a company's competitive advantages has been found to be one of the main threats to sustained market success in rapidly evolving business environments (Ilmola et al., 2002).

Weak signals may be defined as advanced indicators of change phenomena. They do not necessarily strike the potentially interested observer as such. Among the abundant delivery of sensorial stimuli, amidst a sea of noise, there may be premature, incomplete, unstructured, and fragmented informational material pointing to the emergence of challenging transformations. (Mendonca et al. 2012, 220)

Decker et al. (2005) studied the use of an Internet based tool for environmental scanning in marketing planning, which aims to reduce obstacles hindering the observation of weak signals. The tool facilitates the choice of information sources and saves the user's time for work on the more demanded tasks. The main benefit of the research was the integration of weak signals into the information search process of the strategic planning and marketing.

Könnölä et al. (2007) introduced a collaborative foresight method called RPM-Screening for the analyses of weak signals in the context of prospective innovations. The seemingly heavy process consists of phases for the generation, revision, multi-criteria evaluation, and portfolio analysis of innovation ideas.

Overall, the pilot project produced 166 prospective innovation ideas of which many were quite promising: for example, several ideas were adopted into the Delphi-process of a regional foresight project. The ideas were also disseminated to enterprises, universities, research centers, ministries and regional development centers through websites, workshops and seminars. (Könnölä et al. 2007, 619)

Scenarios try to depict plausible and internally consistent visions of future. Herman Kahn is considered one of the founders of futures studies and father of scenario planning, defines scenario in his book (Kahn, 1967) as ‘‘a set of hypothetical events set in the future constructed to clarify a possible chain of causal events as well as their decision points. Systematic use of scenarios for clarifying thinking about the future started after the World War II and US Department of Defense used it as a method for military planning in 1950s at RAND Corporation.

Scenario planning has been extensively used at corporate level. At corporate level Shell is considered the most celebrated and best-known user of scenarios in the world for business context and usage of scenarios has helped the company to cope with the oil shock and other uncertain events in 1970s. (Amer et. al. 2013, 24)

In 1985, Wack (1985, 150) defined scenario planning as: “a discipline for rediscovering the original entrepreneurial power of foresight in contexts of change, complexity and uncertainty”

It can be concluded that scenario planning approaches comprising of a combination of qualitative and quantitative techniques are better and can result in generating robust scenarios. Also it is critical to develop appropriate number of scenarios. Based on detailed analysis it can be concluded that 3–5 future scenarios are appropriate for a scenario project. (Amer et. al. 2013, 38)

In Kees van der Heijden`s book (1996) scenario planning relies not on probability but on qualitative causal thinking. As such it appeals more to the intuitive needs of the typical decision makers in their search for enhanced understanding of the changing structures in society and scenarios are described as a set of reasonably plausible, but structurally different futures (Heijden 1996, 15-29).

2.1.7 Thoughts and summary on foresight

The relevant challenge in foresight activity seems to be to recognize and realize the qualitative and quantitative aspects of change in phenomenon and systems and the interaction between them. Therefore, it is logical to apply qualitative and quantitative analysis and tools in the process.

Having researched the scientific history and background of the methodologies it appears that when you want to

- get quantitative results or utilize e.g. time series you should use trend analysis, regression, economic indicators and probability calculus
- understand connections between events, trends and action you should use cross impact analysis, decision trees, simulations, futures wheels, causal layered analysis and other soft system methodologies
- reach visionary state you should use interviews, polls, future workshops, brainstorming and Delphi
- describe alternative plausible futures you should use scenarios, roadmaps, simulations, technology sequence analysis

The literature review seems to suggest that it is beneficial to use several methods to triangulate the research question like it is normal in other research areas. Overall choice of methods should be subordinated to research objectives. It is also vital that the people are aware of their own filters of perception and utilize the techniques professionally and carefully and allow phenomenon and signals to arise from the background noise without excluding them based on assumptions. The level of residual uncertainty is still a combination of the value drivers that exist in the business environment being researched. Even though the process of foresight might with some methods seem somewhat binary it is clear that because of the complexity of business in general, megatrends and instability even in legislation in global competition, foresight is very demanding and requires methodology, skilled people and intuition to carry its full weight in the board room when strategy is pinned down.

If the anticipation is using exclusively quantitative analyses are several important qualitative changes ignored (Denzin 2001). If, however the anticipation is using solely qualitative methods, are again significant quantitative scale factors and changes ignored.

Aaltonen and Barth (2005, 52) also suggest that a futures research method in use be considered as a coalescent method whenever it provides a larger environment inside which other methods can "talk" and a futures research method in use be considered as reflectively adaptive to an environment, e.g. a social, technical and natural environment, whenever it is intrinsic to a futures research method in use that it should be responsive to an environment.

Aaltonen and Sanders summarize that no single method should be trusted; an insightful combination of various, even contradictory methods can create foresight. In fact, every foresight exercise should create and use necessary information from all the necessary sources, and then finish the exercise with methods that stand in the social complexity domain (like the arrow in Figure 10 depicts), where nonlinear developments, and therefore emergence of new practices are possible (Aaltonen and Sanders 2006, 34).

2.2 SWOT

Some authors credit SWOT to Albert Humphrey, who led a convention at the Stanford Research Institute (now SRI International) in the 1960s and 1970s using data from Fortune 500 companies. However, Humphrey himself does not claim the creation of SWOT, and the origins remain obscure. The degree to which the internal environment of the firm matches with the external environment is expressed by the concept of strategic fit.

SWOT is a method which first identifies factors internal to the organization (resources, capabilities, etc.) and classifies them in terms of Strengths and Weaknesses. It similarly examines and classifies external factors for example, or the behaviour of opponents, competitors, markets, and presents them in terms of Opportunities and Threats.

Figure 15 SWOT (anonymous source)

- Strengths: characteristics of the business that give it a competitive advantage over others.
- Weaknesses: characteristics that place the business at a disadvantage relative to others.
- Opportunities: elements that the business could leverage to its advantage.
- Threats: elements in the environment that could represent a threat to the business.

It is worth pointing out that whereas SWOT analysis is often not seen strictly speaking as a foresight method, it may be good to consider it from this perspective. Foresight is particularly useful for addressing the OT dimensions, whereas SWOT analyses often fail because of poor examination of OT (opportunities and threats).

2.3 PESTEL

The term PESTLE, PESTEL, STEEPL etc. has been used regularly in the last 2 decades and its true history is difficult to establish.

From the research, the earliest known reference to tools and techniques for 'Scanning the Business Environment' appears to be a book by Francis J. Aguilar (1967) who discusses 'ETPS' – a mnemonic for the four sectors of his taxonomy of the environment: Economic, Technical, Political, and Social.

Shortly after its publication, Arnold Brown for the Institute of Life Insurance (in the US) reorganized it as 'STEP' (Strategic Trend Evaluation Process) as a method to organize the results of his environmental scanning. Thereafter, this 'macro external environment analysis', or 'environmental scanning for change', was modified yet again to become a so-called STEPE analysis to include Ecological taxonomy.

In the 1980s, several other authors including Morrison, Renfro, Boucher, Mecca and Porter included variations of the taxonomy classifications in a variety of orders: PEST, PESTLE, STEEPLE etc. Why the slightly negative connotations of PEST have proven to be more popular than STEP is not known. There is no implied order or priority in any of the formats.

Fahey, King and Narayanan (1981, 36) found in their research that "change in the company environment was occurring at such a rapid rate that those who formulate plans and/or managers who must implement a set of plans could no longer be charged with responsibility for predicting and assessing potential change in a range of environments as diffuse as the political, economic, technological and social arenas."

Figure 16 PESTEL (anonymous source)

Political factors can include e.g. tax policy, employment laws, environmental regulations, trade restrictions and tariffs and political stability, government type, freedom of press, rule of law, levels of bureaucracy and corruption, regulation and de-regulation trends, likely changes in the political environment

Economic factors can include e.g. economic growth, interest rates, exchange rates and inflation rate, stage of business cycle, inflation & interest rates, unemployment and labour supply, labour costs, levels of disposable income & income distribution, impact of globalization, likely impact of technological or other change on the economy, likely changes in the economic environment

Social factors can include e.g. health consciousness, population growth rate, age distribution and emphasis on safety, population health, education & social mobility, and attitudes to these, population employment patterns, job market freedom & attitudes to work, press attitudes, public opinion, social attitudes & social taboos, lifestyle choices and attitudes to these

Technological factors can include e.g. R&D activity, level of automation, technology incentives and rate of technological change, impact of emerging technologies, impact of internet, reduction in communication costs & increased remote working

Ecological or environmental factors can include e.g. weather, natural disasters, climate, climate change, environmental taxes, demand for "green" products

Legal factors can include e.g. antitrust law, consumer law, discrimination law, employment law, health & safety laws

2.4 Technology roadmap in product development

Technology management addresses the processes needed to maintain a stream of products and services to the market. It deals with all aspects of integrating technological issues into business decision making, and is directly relevant to a few business processes, including strategy development, innovation and new product development, and operations management.

Roadmap is a method which outlines the future of a field of technology, generating a timeline for development of various interrelated technologies and (sometimes) including factors like regulatory and market structures. It is a technique widely used by high-tech industries, where it serves both as a tool for communication, exchange, and development of shared visions, and as a way of communicating expectations. In a different situation, such as when a strategic, discontinuous change approaches from the outside, the road mapping process may not provide early warning.

Groenveld (1997) defined road mapping in simple terms to be a process that contributes to the integration of business and technology and to the definition of technology strategy by displaying the interaction between products and technologies over time taking into account both short- and long-term product and technology aspects (Groenveld 1997, 48). Technology road mapping is a flexible technique that is widely used within industry to support strategic and long-range planning. The approach provides a structured (and often graphical) means for exploring and communicating the relationships between evolving and developing markets, products and technologies over time. It is proposed that the road mapping technique can help companies survive in turbulent environments by providing a focus for scanning the environment and a means of tracking the performance of individual, including potentially disruptive, technologies. (Phaal et. al. 2004, 5)

Roadmaps can take various forms, but the most common approach is encapsulated in the generic form proposed by European Industrial Research Management Association EIRMA (1997). The generic roadmap is a time-based chart, comprising a number of layers that typically include both commercial and technological perspectives. The roadmap enables the evolution of markets, products and technologies to be explored, together with the linkages between the various perspectives. Below is the generalized technology roadmap structure from Moehrle et. al. 2013.

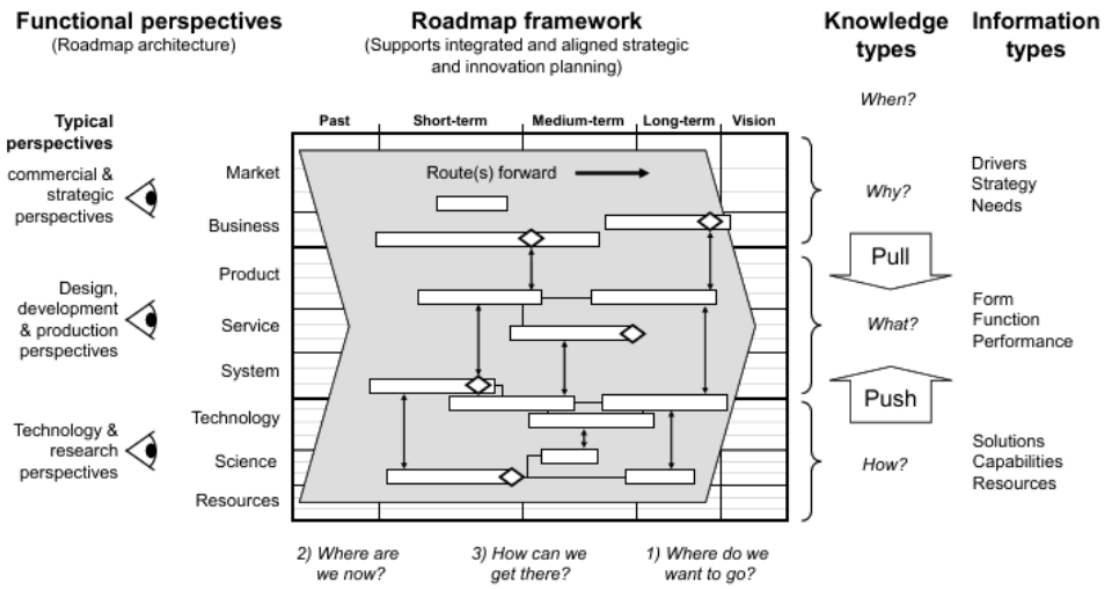


Figure 17 Generalized technology roadmap structure (Moehrle et. al. 2013, 20)

A survey of 2,000 UK manufacturing firms (Phaal et al., 2001) indicates that about 10% of companies (mostly large) have applied the technology road mapping approach, with approximately 80% of those companies either using the technique more than once, or on an ongoing basis.

The road mapping approach was developed at Motorola to improve the alignment between technology and innovation (Willyard and McCless, Motorola's technology roadmap process). Its application became popular during the last decade and it was adopted by companies, governments and other institutions. The road mapping approach includes two main components, namely the application (i.e., the road mapping process) and the result of the application (usually a map known as the roadmap). Therefore, the word “roadmap” represents a summary of science and technology plans in the form of maps, and the road mapping process is the development of this roadmap. Although a roadmap can be presented in several forms, it usually includes a multilayer graphical representation of a plan that connects technology and products with market opportunities. (Carvalho et. al. 2013, 1418)

The classic example of industry technology road map is the 'International Technology Roadmap for Semiconductors (ITRS)', first published in 1999, which originated from the US-based 'National Technology Roadmap for Semiconductors' (NTRS). It is a cooperative effort of the global industry manufacturers and suppliers, government organizations, consortia, and universities from virtually every country active in this field to ensure advancements in the performance of integrated circuits by identifying the technological challenges and needs facing the semiconductor industry over the next 15 years. It has become the world-wide reference document for the semiconductor industry. However, it remains a specific case which is not transferable as such into slower-moving industries.

According to Carvalho et. al. (2013) until the end of 2003 only a few papers about road mapping were cited. The paper that was cited first and most frequently was Groenveld. Groenveld analysed road mapping initiatives at Philips Electronics with a primary focus on the early stages of the new product development process and found that road mapping improved the integration between the company's business strategy and technology management. (Carvalho et. al. 2013, 1422)

Dissel et. al. 2009 claims that many decisions are still made based on expert judgment and gut feel. However, few approaches exist that attempt to structure and utilize individual expert judgments and gut feel in order to improve investment decisions. Value road mapping is a candidate solution to address this gap. The Value Roadmap approach is based on technology road mapping concepts and value streams are the sources of future revenue and savings: products, services, business/ facilities, technology/ IP, cost/risk reduction, strategic position. All of these value streams relate directly to the generation of cash revenue, except for “strategic position,” which includes all non-financial factors that provide a foundation for future revenue generation.

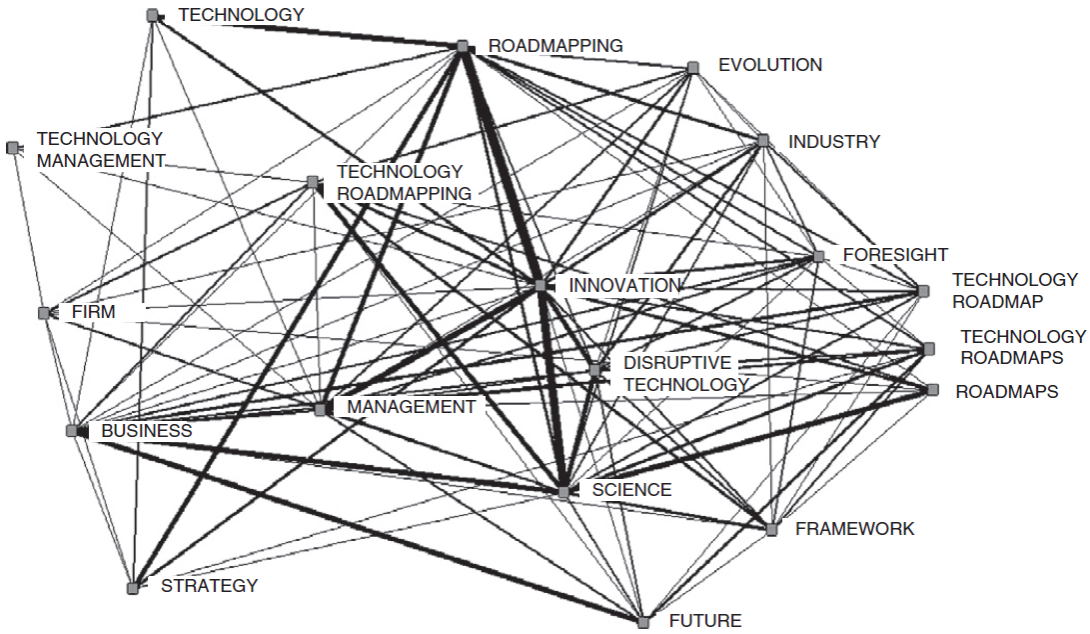


Figure 18 Keyword network (Carvalho et. al. 2013, 1424)

The literature overview by Carvalho et. al. (2013) also depicts the keyword network in the research papers released. The overview covers papers released between 1997 and 2011 with peer-review containing metadata "technology road mapping", "technology-road mapping" or "road mapping" from the ISI-web of science database. The strength of ties corresponds to the relationship intensities. It could loosely be interpreted as the bridging roles in the network and the liaison between different interest groups. Almost 52% of the articles had the product development perspective and remaining 48% strategy and business perspective.

Technology management framework (Probert et al., 2000), showing technology management processes (Identification, Selection, Acquisition, Exploitation and Protection), business processes (strategy, innovation and operations), highlighting the dialogue that is needed between the commercial and technological functions in the business to support effective technology management.

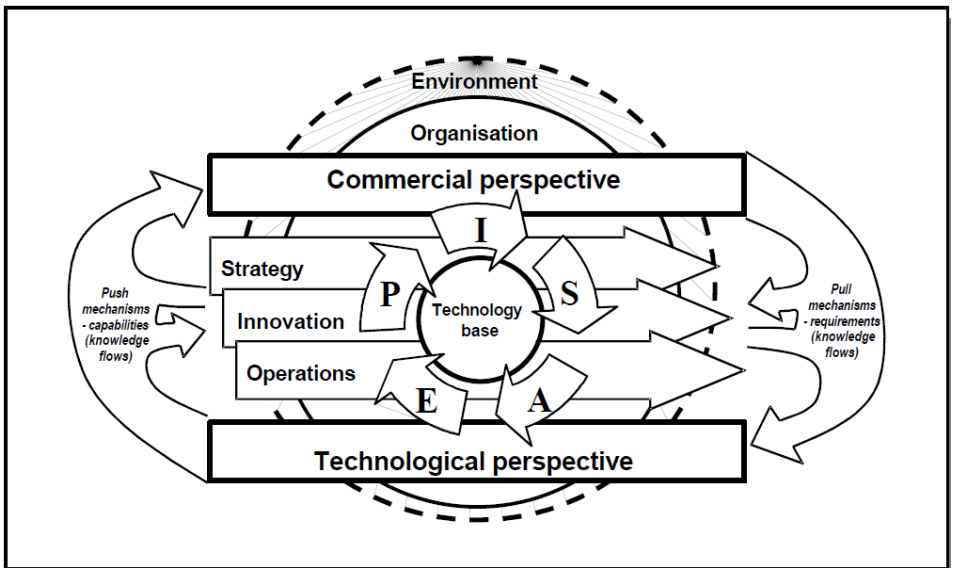


Figure 19 Technology management framework (Probert et al., 2000)

According to Kappel (Kappel 2001, 44) road mapping is most useful when in growth phase of a product or a market, when product or process technology is the recognized basis of competition, in organizations that fit their environment, in predictable regimes or strong influence on external environment or existing markets experiencing sustained progress when coordination is otherwise difficult and customer voice needs strengthening.

Finally Phaal et al. (2004) proposes a standard process for making a roadmap

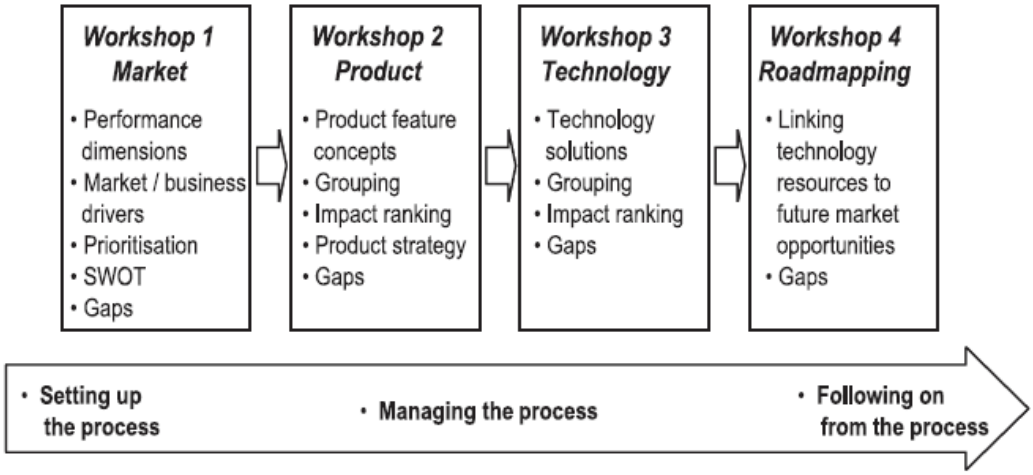


Figure 20 T-Plan: standard process steps (Phaal et. al. 2004, 17)

Setting up the roadmap exercise a number of interdisciplinary workshops make sense of the market-pull and technology-push factors and consider the gaps that exist in the market that could be covered. In the roadmap exercise these areas are combined into a uniform view linking the technology resources to the future market opportunities.

2.5 Life cycle models in market, product based and technological forecasting

Products inherently are born and die and cannot be expected hold permanent position in the market place. The lifetime sales of many products have proven a pattern known as the product life cycle. From base technology point of view also technologies come and go and new opportunities are born when old technologies fade away. As an example of these two the introduction of flat screen TV`s was made possible by introduction of the screen technology and semiconductors and the market for the cathode ray tube television has died in modern economies. Simultaneously CRT TV`s still exist, can be used and are sold second hand in less developed economies. This is just one example of the fact that product lifecycle and technology lifecycle although close to each other are separate phenomenon.

There is less proof of Gartner hype cycles validity as a realistic model but it is often referred to in the context of emergence of new things that have the potential to be industry transforming in one way or the other. Sometimes the rise and fall of these new technologies is just a hype.

2.5.1 Product lifecycle (PLC)

Looking at roadmaps one cannot avoid making a detour to a subject that is very relevant to product life cycle design. Empirical studies suggest that the adoption of a new technology follows a bell-curve or normal distribution curve (Norris and Vaizey, 1973). By plotting cumulatively this shows the number of e.g. companies that have adopted a new technology in any given year and the distribution will give a S-shape curve. It was Gabriel Tarde who in the Laws of Limitation 1903 proposed that adoption plotted against time assume a normal distribution or if plotted cumulatively assume the S-shape curve (Baker 1976)

No product can be expected to hold permanent position in the market place. The lifetime sales of many products have proven a pattern known as the product life cycle. The concept aims to explain how suppliers make the suitable and well-timed decisions in diffusing new technology effectively to adopters. In consumer goods the probability of a new user adopting technology depends on the quality of experience enjoyed by the existing users. Good sales practice is expensive but leads to a high proportion of satisfied users, which is positive for subsequent diffusion. In business to business market diffusion might follow the same pattern but the introduction or development slope of diffusion might be somewhat gentler.

In an age of dynamic product competition, product-line pruning must be considered as a problem on a par with product improvement and new-product development. Yet managers have no systematic procedure for pruning weaker products (Kotler 1965, 118). Kotler describes the products four life cycle stages as innovation, growth, maturity and decline. Kotler refers to Arch Patton’s article in the Management review in June 1959

”Top management´s stake in the Product life cycle” so the term is older than typically imagined. First reference to the term was found to be by Joel Dean in 1950 about pricing policies for new products where he stated that, A decision to price for market expansion can be reached at various stages in a product's life cycle: before birth, at birth, in childhood, in adulthood, or in senescence (Dean 1950, 51).

Theodore Levitt was the first one to describe the pattern as a curve in sales vs. time and called the first stage market development. William Cox (Cox 1967, 377) agreed on the shape of the curve in his concept of “product life cycle as marketing model” in 1967. He called the first stage introduction stage.

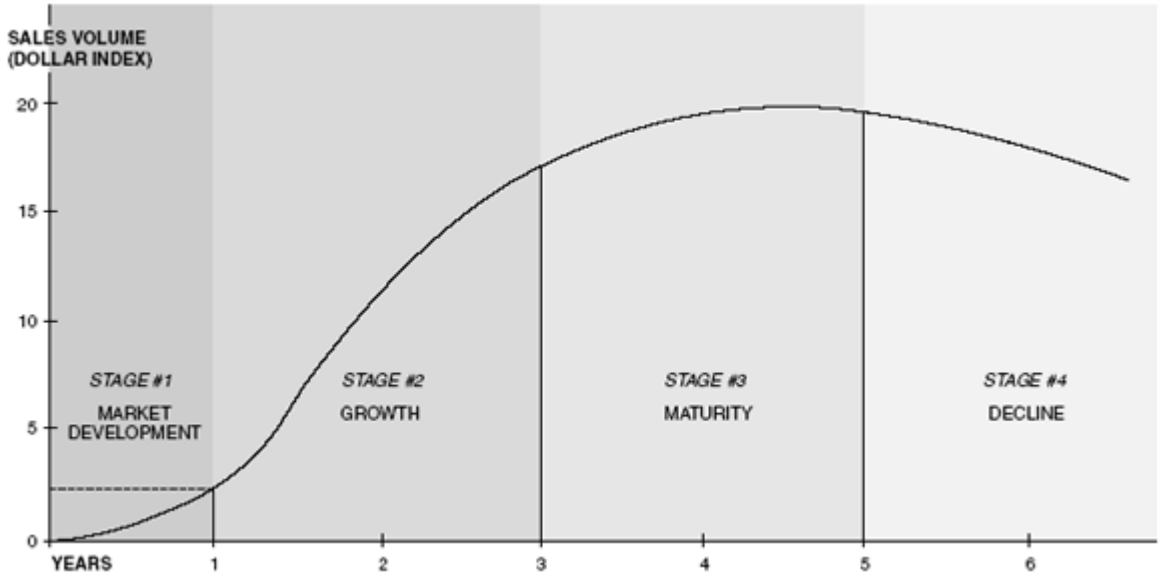


Figure 21 Product life cycle – entire industry (Levitt 1965, 82)

After a product is put on the market awareness and acceptance are minimal. The product begins to make rapid sales gains and enters maturity as the growth stalls. The sales begin to diminish as the product is gradually edged out by better or newer products or substitutes. The rationale in discarding weaker products comes from better profit potential of other products or from re-allocating the resources needed instead of keeping them bound to a product with declining profit potential. The concept of product life cycle (PLC) was later defined and established both empirically and theoretically in the literature (Brockhoff, 1967; Day, 1981; Harrell and Taylor, 1981; Midgley, 1981; Easingwood, 1988; Bass, 1995 in Kim 2003).

Levitt stated that looking ahead gives more perspective to the present than looking at the present alone. Most people know more about the present than is good for them. It is neither healthy nor helpful to know the present too well, for our perception of the present is too often too heavily distorted by the urgent pressures of day-to-day events. To know where the present is in the continuum of competitive time and events, it often makes more

sense to try to know what the future will bring, and when it will bring it, than to try to know what the present itself actually contains. (Levitt 1965, 87)

Levitt speculated that subsequent extensions of a product lifecycle could be repeatedly and systematically extended and stretched it can serve as a model for other products.

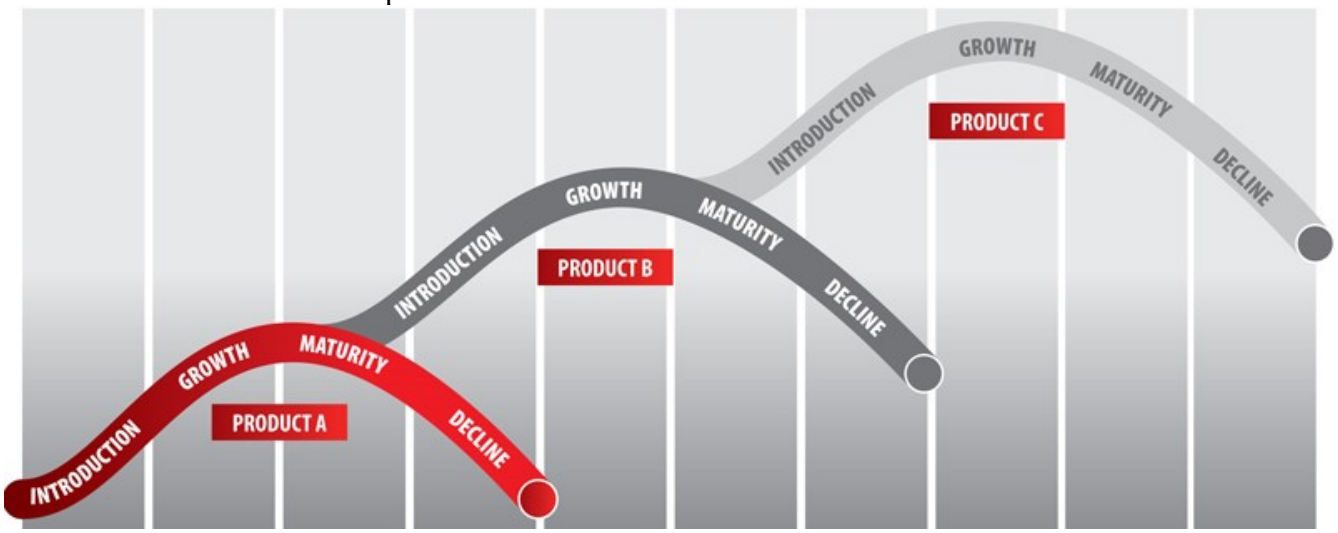


Figure 22 Hypothetical life cycle (adapted from Levitt 1965, 88)

Levitt suggested that for companies interested in continued growth and profits, successful new product strategy should be viewed as a planned totality that looks ahead over some years. For its own good, new product strategy should try to predict in some measure the likelihood, character, and timing of competitive and market events.

Looking at the curve one could reason then if the switching cost from old product to new is very high, it becomes necessary to find an entry timing so as to avoid the excessive penalty by making the entry time closer to the maturity point of the old product. The attributes of the old product are dominating those of the new one. However, when the switching penalty is small, the optimal timing for the new product to enter the market becomes a function of the new product's uncertainty, i.e. one of the most important attributes of the new product.

2.5.2 Technology life cycle (TLC)

The technology life-cycle (TLC) describes the commercial gain of a product through the expense of research and development phase, and the financial return during its useful life. The TLC associated with a product or technological service is different from product life-cycle (PLC) dealt with in product life-cycle management. The latter is concerned with the life of a product in the marketplace with respect to timing of introduction, marketing measures, and business costs. The technology life cycle is concerned with the time and cost of developing the technology, the timeline of recovering cost, and modes of making the technology yield a profit proportionate to the costs and risks involved. Some researchers view the TLC re-

lated with generations of technology derived from the same technological platform. Defining the TLC in this way leads us to have a more macro perspective than in studying the PLC, where the focus is usually on the individual firm's product/service (Kim 2003, 372).

There are many varying meanings to TLC and academia is using the terms industry life cycle, product life cycle and technology life cycle interchangeably, ambiguously and often inappropriately. Moreover, the discourse is dominated by the product life cycle (PLC) while the technology life cycle (TLC) has largely been neglected.

Taking the time and money business gain approach, which is relevant to real world product portfolio management the TLC curve contains (A) The research and development phase when incomes from inputs are negative and where the prospects of failure are high and risks are taken to invest in technological innovation. By strategically directing R&D towards the most promising projects, rigorously selecting the viable options from innovation funnel companies try to develop their offering (B) The ascent phase when out-of-pocket costs have been recovered and the technology begins to gather strength by going beyond a point A on the TLC and company goal is to see to the rapid growth and distribution of the technology and leverage the competitive advantage of having the newest and most effective product (C) The maturity phase when gain is high and stable as the new innovation becomes accepted by the market and competitors enter, supply begins to outstrip demand and possibly make previous generations obsolete. During this stage, returns begin to slow as the concept becomes the norm, going into saturation and (D) The decline up to Point D, potential value to be captured in producing and selling the product begins to lose. This decline eventually reaches the point of a zero-sum game, where margins are no longer procured to even loss from supporting the technology that is phasing out. This curve in fact goes quite well in sync with BCG matrix quadrants.

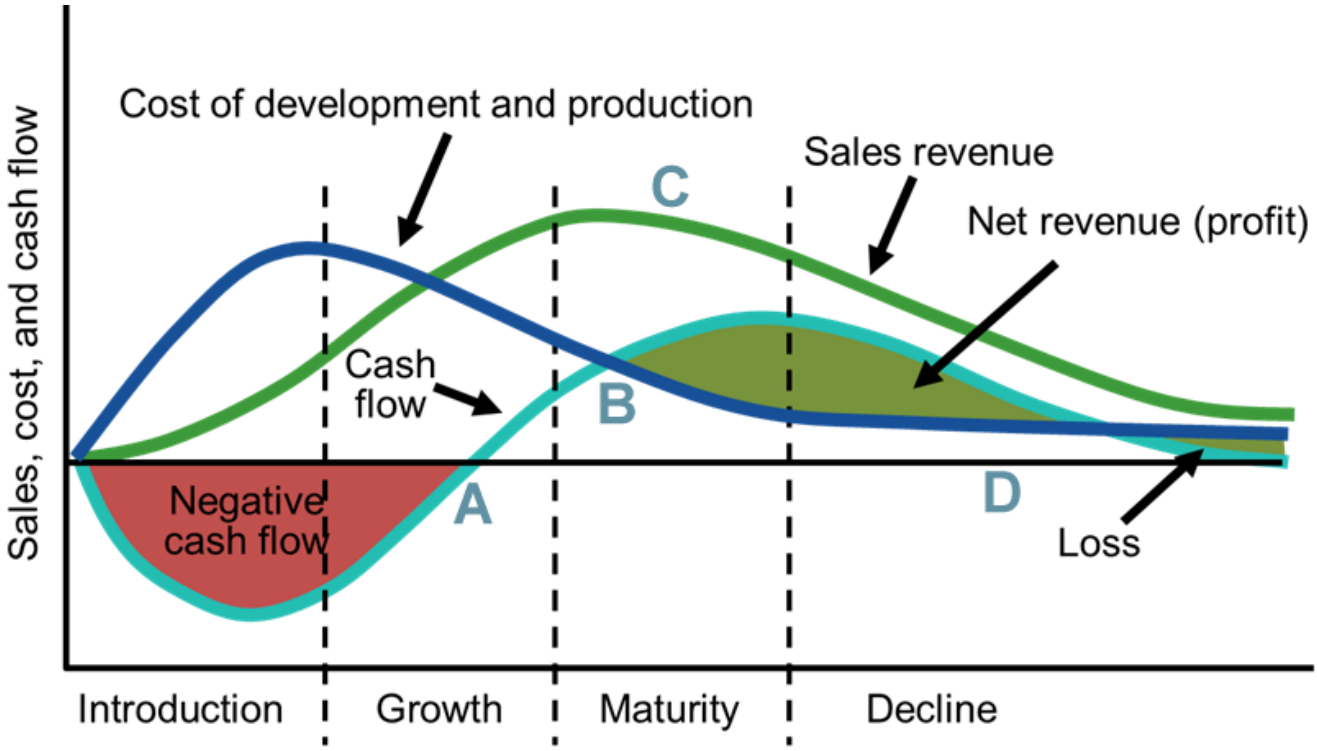


Figure 23 Technology life-cycle

The TLC may, further, be protected during its cycle with patents and trademarks seeking to lengthen the cycle and to maximize the profit from it. There are always smaller firms (SMEs) who are inadequately situated to finance the development of innovative R&D in the post-research and early technology phases. By sharing incipient technology under certain conditions, substantial risk financing can come from third parties.
Licensing a patented technology is possible in the ascent stage of the technology that may command premium profit or gain, maturity phase to lower risk of decline in profitability or decline phase of technology to extend the profits in decline.

2.5.3 Gartner hype cycle

The marketing literature has probably been the first to recognize the high-rising expectations that may be considered a hype that attracts attention, support, social media trending and complementary assets that can be leveraged in the diffusion of market entry. Hypes are followed by disappointment when high expectations are not met by actual innovative outcome or market penetration.

The Hype Cycle is a branded graphical presentation developed and used by US Information Technology (IT) research and advisory firm Gartner for representing the maturity, adoption and social application of specific technologies. Gartner's Hype Cycle, introduced in 1995, characterizes the typical progression of an emerging technology from overenthusiasm through a period of disillusionment to an eventual understanding of the technology's relevance and role in a market or domain. The Hype Cycle provides a graphical and conceptual presentation of the maturity emerging

technologies through five phases: Technology trigger, Peak of inflated expectations, Trough of disillusionment, Slope of enlightenment and Plateau of productivity.

Even though the trend curve is well known to product developers and marketers it has been criticized along the lines that it is not a cycle, that the outcome does not depend on the nature of the technology itself, that it is not scientific in nature and that it does not reflect changes over time in the speed at which technology develops. Another is that the "cycle" has no real benefits to the development or marketing of new technologies and merely comments on pre-existing trends. Quite a fundamental flaw is that the cycle is not scientific in nature, and there is no data or analysis that would justify the cycle.

Van Lente (van Lente et al. 2013, 1626) concluded in a study that hypes differ between fields, and that the conditions of the underlying technology are inherently entangled with the structure of hypes that may occur and Yeon (Yeon et al. 2006, 663) stated that a single model doesn't explain the mechanism of technology diffusion system. This is mainly because each model is like a puzzle with pieces missing unless they are integrated into one.

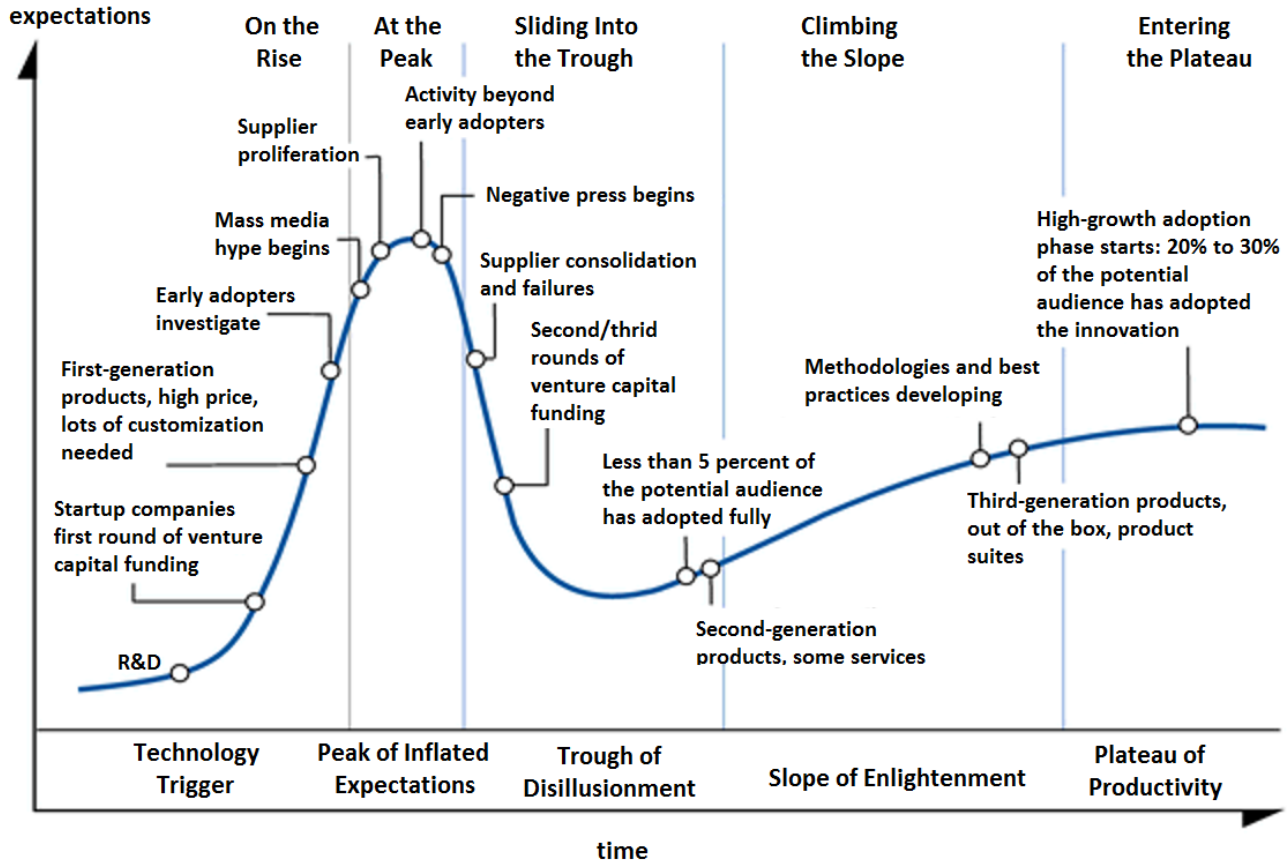


Figure 24 Gartner hype cycle (Gartner 1995)

Gartner's Hype Cycles highlight the relative maturity of technologies across a wide range of IT domains, targeting different IT roles and responsibilities. Each Hype Cycle provides a snapshot of the position of technologies relative to a market, region or industry, identifying which technologies are hyped, which are suffering the inevitable disillusionment and which are stable enough to allow for a reasonable understanding of when and how to use them appropriately (Gartner, 2005)

2.5.4 Innovation project portfolio management

Portfolio management is a dynamic decision process normally referred to as picking the right (product) development projects by continually updating and revising the list of active product development projects for the limited resources available (Cooper et al., 1997). Based on the portfolio decisions, new projects may be selected and prioritized, while existing projects might be cancelled or de-prioritized. Portfolio management is critical since poor portfolio decisions that are not in line with the company's strategy may have a significant negative impact on performance results such as far too many product project, projects that are not aligned with the business strategy or a reluctance to kill projects (Chao and Kavadias, 2008; Cooper et al., 2001). To address these issues mentioned, a long-term perspective is needed in order to select the right projects. (Brugh, Bellgran 2014, 157)

A common theme in the literature on Project portfolio management PPM is the assertion that adopting certain methods or establishing best practices will improve innovation outcomes (Cooper et al., 2001; Matheson and Matheson, 1998), however empirical research in this area is limited (Killen et al., 2007).

Project portfolio management fits well into this literature review because it combines the PLC and TLC lifecycle models into one model into an integrated market-technology portfolio model which resonates well at in the mind of a researcher that works in a market pull-technology push world of technology based industry that innovates products and produces them to the market.

The empirical research strongly supports the proposition that no single PPM method will be appropriate for all situations and that customized PPM processes need to be developed to suit the situation. Some of the research supports the proposition that PPM formality will lead to better portfolio outcomes, but other findings show that a more formal PPM process is not necessarily the best approach. This indicates that the level of formality may be one of the aspects of PPM that needs to be tailored to suit the types of projects and the environment. (Killen et al., 2007 p.1871)

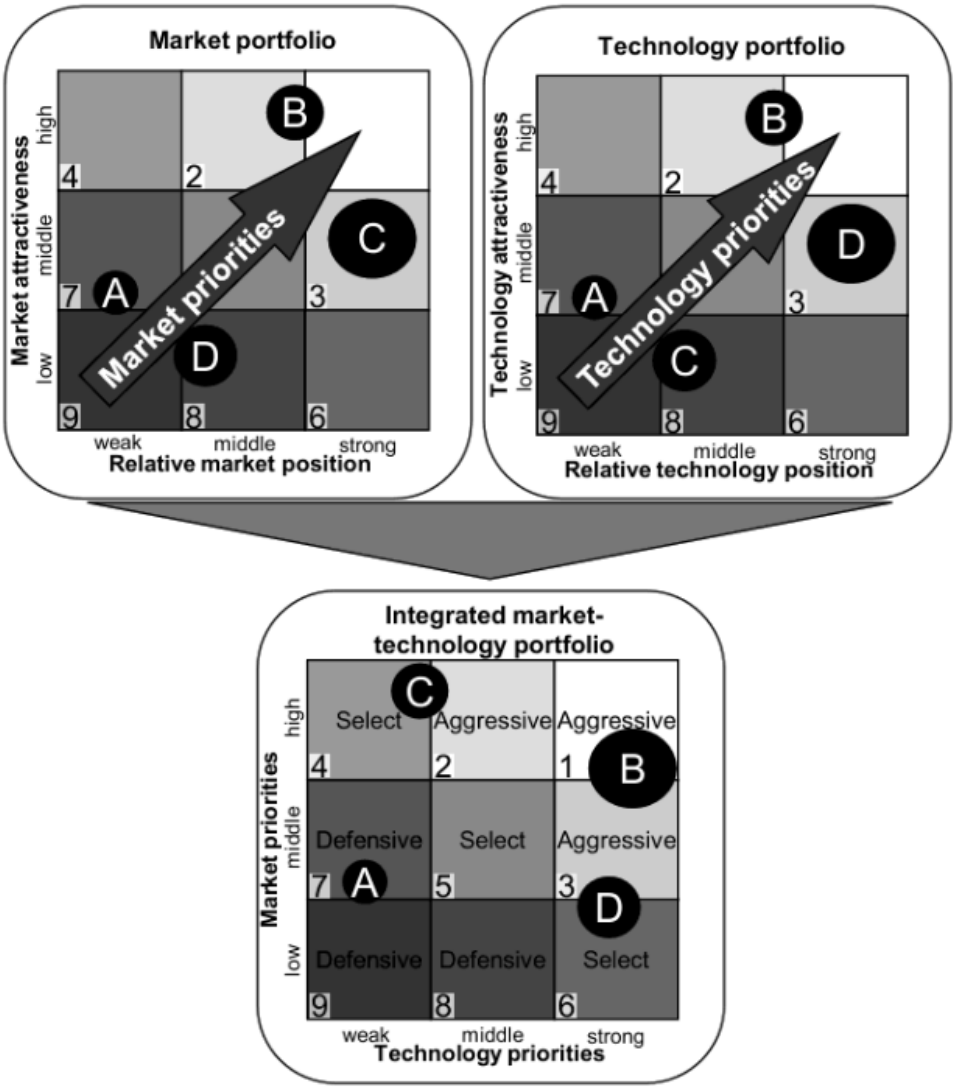


Figure 25 Innovation business plan – core of portfolio analysis methodology (Moehrle et. al. 2013, 217)

The McKinsey approach generally comprises of a technology portfolio and a market portfolio which is then combined into an integrated portfolio. The technology portfolio addresses technology attractiveness and the relative technology position. In essence, the attractiveness of a technology depends on its position on the S-curve (Foster, 1986). The market portfolio addresses market attractiveness and the relative market position. The S-curve is a tool for the description of the market penetration of a product or service. It shows how much development potential still exists and how much costs of promoting will be needed. The combined or integrated market-technology portfolio then combines the views based on market attractiveness and competitive position in the respective market.

This approach again resonates quite well with the market pull – technology push idea and essentially offers nothing new in that sense. What it offers is the distinction that technology-related priorities for R&D are established based on the technology's position in the portfolio. At this point, a distinction is drawn between three model R&D investment strategies - i.e. aggressive, selective and defensive - which also indicate the strategic direction of impact. As shown in the figure above it makes more sense to

look at the combined portfolios than at each of them separately. For instance, product 'D' has the weakest position in the market portfolio and would gain only minor resources on this basis, but it has a high priority in terms of technology and would hence be best served by the selective R&D strategy (Moehrle et. al. 2013, 217).

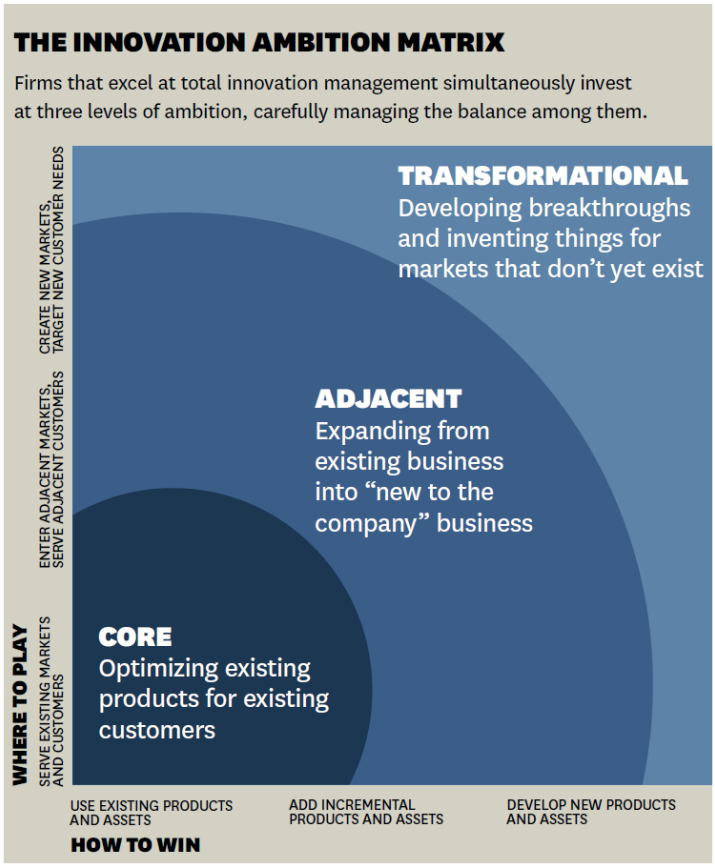


Figure 26 Innovation Ambition Matrix (Nagji&Tuff, 2012)

Innovation Ambition Matrix is depicted above. Students of management will recognize it as a refinement of a classic diagram devised by the mathematician H. Igor Ansoff to help companies allocate funds among growth initiatives. Ansoff's matrix clarified the notion that tactics should differ according to whether a firm was launching a new product, entering a new market or both. Nagji&Tuff's version replaces Ansoff's binary choices of product and market (old versus new) with a range of values. This acknowledges that the novelty of a company's offerings (on the x axis) and the novelty of its customer markets (on the y axis) are a matter of degree. They have overlaid three levels of distance from the company's current, bottom-left reality. (Nagji&Tuff, 2012)

In a study of companies in the industrial, technology, and consumer goods sectors, Nagji and Tuff (2012) looked at whether any particular allocation of resources across core, adjacent, and transformational initiatives correlated with significantly better performance as reflected in share price. Indeed, the data revealed a pattern: Companies that allocated about 70% of their innovation activity to core initiatives, 20% to adjacent ones, and 10% to transformational ones outperformed their peers, typically realizing a P/E premium of 10% to 20%. (Nagji&Tuff, 2012)

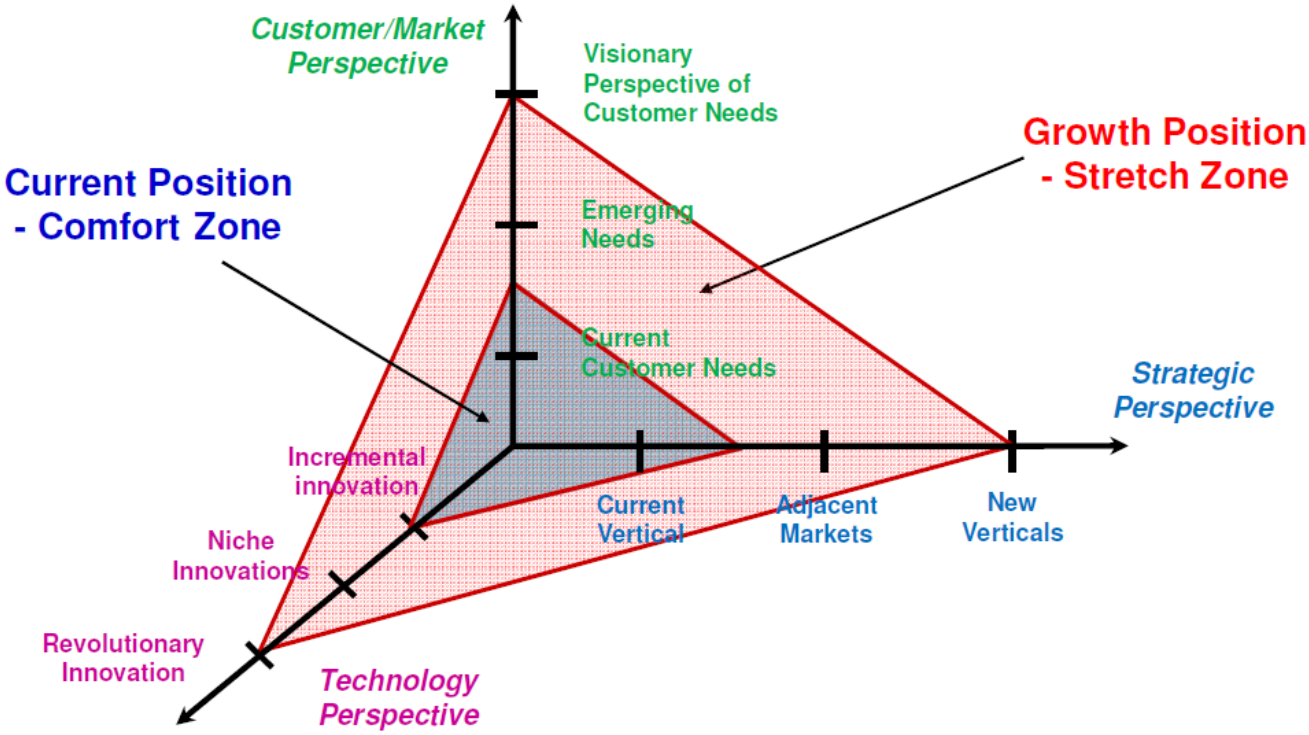


Figure 27 Convergence of market, technology and strategy (Baul-Lewis, 2013)

Managing innovation for profit and growth should take into account the all the axis i.e. again the market and the technology view but also the strategic perspective by expansion into business verticals. Foresight activities are clearly in this figure a key element into the customer perspective and entering the growth zone before the competition does.

2.6 Product portfolio management

Product portfolio was first referred to by Bruce Henderson in the Boston consulting group in 1970 (Henderson, 1970) and designing product and business portfolios in 1981 by Wind & Mahajan (Wind & Mahajan, 1981).

Business dictionary (Business dictionary, 2015) defines product portfolio to be "A combination of two or more product families".

Portfolio management is a cross-functional capability that enables a holistic view of the entire project portfolio, with an emphasis on selection criteria, assessment, decision making and governance as well as the balance among projects. (Kandybin 2009, 59)

A company cannot waste its financial and manpower resources by developing products at random not knowing how they land on the market place. According to Boston Consulting Group to be successful, a company

should have a portfolio of products with different growth rates and different market shares. Product portfolio can be seen as the offering a company has at any given time to satisfy the needs and expectations of the customers. Product portfolio management can be construed as resource allocation to achieve corporate product innovation objectives.

Corporate chief technology officers are faced with many responsibilities: Apart from overseeing, acquiring, preserving and developing technological competencies, they are expected to take part in technological positioning of their company by managing the offering.

Since the late 1960`s a lot has been written about diversifying a company`s operations as a portfolio of businesses. The techniques that exist typically serve at a corporation level in designing the business strategy rather than developing competition strategy within single industry. Despite that they can provide a useful tool in understanding some of the questions that competitor analysis raises if the systemic limitations are understood.

The main impetus to portfolio planning models was the wave of diversification that took place in the 1960s, which led companies into new, often unrelated, businesses. As diversity increased, so did the strains on managements' cognitive capacities; that is, it became increasingly difficult for executives at the top of diversified firms to understand all of the competitive situations and economics of each business in which they participated. In addition, the rapid growth characteristic of the 1950s and 1960s often led to severe cash needs, which would outstrip the ability of companies to fund these needs internally. With most businesses in the corporation requesting capital funds simultaneously, financial resources became increasingly scarce. In addition, as inflation accelerated during the 1970s, capital markets became less and less attractive sources for funds. These conditions led executives to seek a method for internal resource allocation. Finally, the diversification trend was accompanied by a trend toward decentralized management, which led business-level managers to behave more autonomously and to make strategic resource allocation decisions independently of each other.

General Electric is perhaps the best-known exponent of the portfolio approach. The models fall into two general categories—the standardized approaches, which usually concentrate on growth and share of market, and the tailor-made varieties, which offer more flexibility in the dimensions along which the products or business lines are measured (Wind, Mahajan 1981).

When there's price pressure in a company's core business, a product-oriented strategy would be to try to boost the return from each product by, for example, giving up price-sensitive customers and pursuing those who are willing to pay more. With a portfolio approach, a company doesn't have to do that—it can protect itself by expanding into sectors that make more money when prices of the company's core products fall.

Product portfolio management is closely related to product strategy. Product portfolio management aims at making strategic decisions about the markets, products and technologies where the company should be active in. It consists of allocating the resources the right way and selecting the right projects and products to concentrate on. (Cooper et al. 1999)

2.6.1 Why do you need product portfolio management?

Effective portfolio management is vital to successful product innovation (Cooper et al. 1999, 333) and for better innovation outcomes, management should place a priority on developing and improving portfolio processes (Killen et al. 2008, 14).

Many management tools and frameworks have been developed by managers, consultants and academics to support the product strategy creation process (Schilling 2008; Phaal et.al. 2006).

The best performers tend to have dispassionate new product portfolio management that is not controlled by any single function (Kandybin 2009, 60).

Cooper et. al. (1999, 349) found in their research that in the above average performing businesses management view portfolio management as very important, the companies have a formal method for portfolio management with well-defined rules and they tend to use multiple portfolio methods more so than other lower performing businesses. The quality of the portfolio method appears to have much more impact on performance results than whether or not the method fits the management style (Cooper et. al. 1999, 349).

Minor innovations make up 85% to 90% of companies' development portfolios, on average, but they rarely generate the growth companies seek (Day 2007, 2).

To balance its innovation portfolio, a company needs a clear picture of how its projects fall on the spectrum of risk (Day 2007, 3).

Is it **R**eal - can we **W**in - is it **W**orth doing is the R-W-W matrix. The less familiar the intended market (*x* axis) and the product or technology (*y*-axis), the higher the risk. See the figure "Assessing Risk Across an Innovation Portfolio" below. Position each innovation product or concept by completing each statement in the left-hand column with one of the options offered across the top to arrive at a score from 1 to 5. Add the six scores in the "Intended Market" section to determine the project's *x*-axis coordinate on the risk matrix. Add the seven scores in the "Product/Technology" section to determine its *y*-axis coordinate.

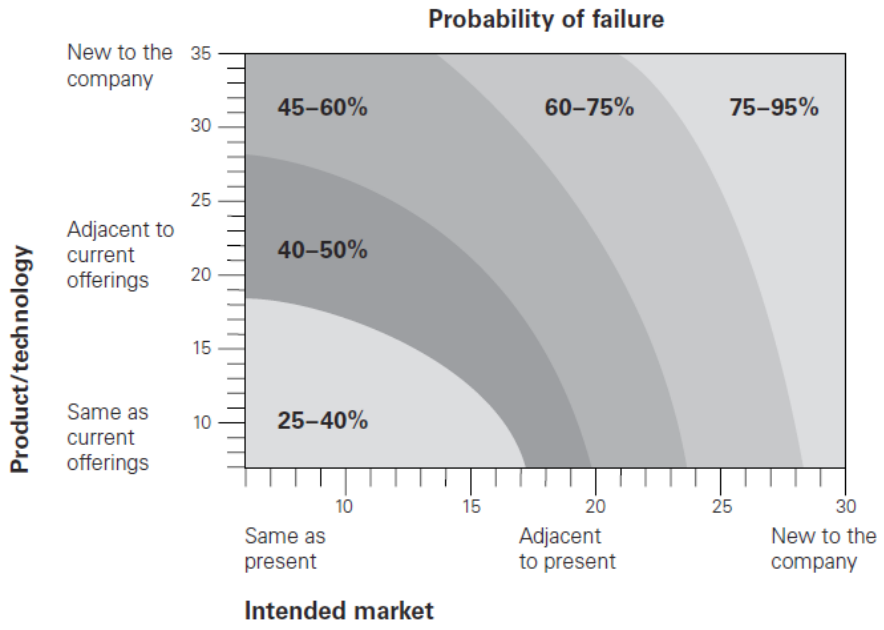


Figure 28 Assessing Risk across an Innovation Portfolio (Day 2007, 4)

Figuring out whether a market exists and whether a product can be made to satisfy that market are the first steps in screening a product concept. After determining that the market and the product are both real, the project team must assess the company's ability to gain and hold an adequate share of the market. Just because a project can pass the tests up to this point doesn't mean it is worth pursuing. The final stage of the screening provides a more rigorous analysis of financial and strategic value. Will the product be profitable at an acceptable risk?

	Intended Market					
	...be the same as in our present market		...partially overlap with our present market		...be entirely different from our present market or are unknown	
Customers' behavior and decision-making processes will...	1	2	3	4	5	
Our distribution and sales activities will...	1	2	3	4	5	
The competitive set (incumbents or potential entrants) will...	1	2	3	4	5	
	...highly relevant		...somewhat relevant		...not at all relevant	
Our brand promise is...	1	2	3	4	5	
Our current customer relationships are...	1	2	3	4	5	
Our knowledge of competitors' behavior and intentions is...	1	2	3	4	5	
					TOTAL (*x*-axis coordinate)	

	Product/Technology					
	...is fully applicable		...will require significant adaptation		...is not applicable	
Our current development capability...	1	2	3	4	5	
Our technology competency...	1	2	3	4	5	
Our intellectual property protection...	1	2	3	4	5	
Our manufacturing and service delivery system...	1	2	3	4	5	
	...are identical to those of our current offerings		...overlap somewhat with those of our current offerings		...completely differ from those of our current offerings	
The required knowledge and science bases...	1	2	3	4	5	
The necessary product and service functions...	1	2	3	4	5	
The expected quality standards...	1	2	3	4	5	
					TOTAL (*y*-axis coordinate)	

Figure 29 Positioning Projects on the Matrix (Day 2007, 5)

Portfolio management is about making strategic choices—which markets, products, and technologies our business will invest in. It is about resource allocation—how you will spend your scarce engineering, R&D, and marketing resources. It focuses on project selection—on which new product or development projects you choose from the many opportunities you face. And it deals with balance—having the right balance between numbers of projects you do and the resources or capabilities you have available. (Cooper et al. 1999)

Common to many studies of the product portfolio is the recognition that the competitive value of market share depends on the structure of competition that can be analysed by e.g. Porter`s Five Forces model and the stage of the product lifecycle familiar from e.g. Kirpalani and Macintosh (Kirpalani&Macintosh, 1980).

Wind et. al. (1983, 98) provide a review of matrix methods. They concluded that it might be advisable to avoid using a single portfolio model

and instead integrate the various models to take advantage of their unique capabilities as they tend to emphasize different portfolio objectives.

Later, it has become apparent that product variety can be provided more efficiently and effectively by creating products based on product platforms (Meyer and Zack, 1996). One of the major advantages of the development of product families is the application of an overall product development strategy that uses common features in the sister design including increase and retirement of products based on changing demand and associated production quantities.

While researching theory on portfolio it came across that findings on non-existing portfolio management could be the same in software business and in the company case of electromechanical business. Vähäniitty et al. (2010) presents a list of eight typical problems that have been associated with inadequate or inefficient portfolio management:

- Excessive multitasking
- Firefighting
- Overload
- Ineffective decision-making
- Missing strategic alignment
- Slipping schedules
- Project failures and poor profitability
- Perceived need to improve project management

A broader portfolio of products—even if some are, for a time, unprofitable—often can help a company capture more value (Anand, 2008). This comes through the heightening of two core strategic challenges facing businesses: getting noticed and getting paid.

2.6.2 Boston matrix as a product portfolio tool

Boston matrix or the growth/share matrix as it is also known as is based on the idea that industry growth and relative market share of a company is dependent on the competitive position of a business in its industry and the relative net cash flow required to run the business. These premises lead to an idea of a portfolio chart that could be used on a strategic level for business units and on a product level for lifecycle management alike to manage the cash flow of a company. That transferred into today`s world leads to the idea that people especially in the consumer goods business are looking for new products just to have new products and everything has its lifecycle.

The BCG approach is to gather large amounts of quantitative data about the economic issues involved in marketing and manufacturing a client's products. This usually includes market size and historical and projected growth, industry and competitor cost structures, and the client's cost structure. This phase essentially involves detailed cost accounting to determine

the profitability and cash flows associated with each SBU (strategic business units) and each product line within each SBU.

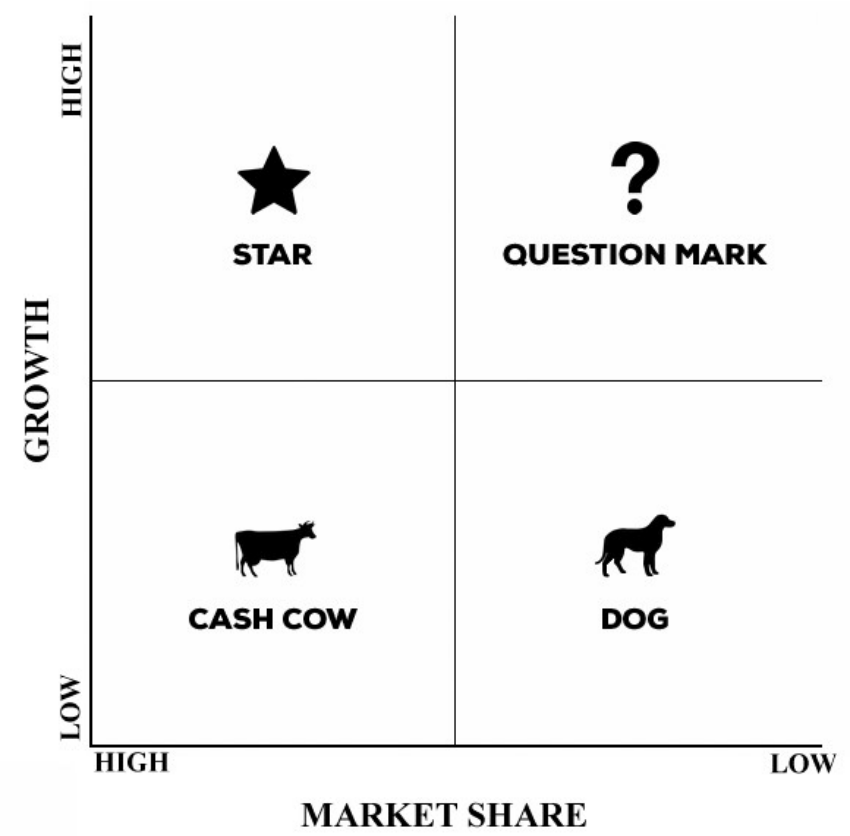


Figure 30 Boston matrix (Adapted from Henderson, 1970)

Turning this into a product portfolio management tool would translate that products with high relative share in low-growth market (Cash cow) will produce a healthy cash flow which can be used to fund other product groups. Ideally the money should be directed into products with low relative share in rapidly growing markets (Question mark) to make them into (Star) products in high relative market share products in high growth markets. The problem with star markets is that it requires a lot of input to retain or grow the market share in rapidly growing markets. Dogs are products that have a low market share in low growth markets that do not use a lot of money but may become traps if the inventory turnover is low. Based on theory alone dogs should be divested or harvested.

There are limitations to the theory. According to Porter the applicability of the portfolio model depends on a number of conditions such as

- The market has been defined properly to account for important shared experience and other interdependencies with other markets. This often a subtle problem requiring a great deal of analysis
- The structure of the industry and within the industry are such that relative market share is a good proxy for competitive position and relative costs. This is often not true

- Market growth is a good proxy for a required cash investment even though profit depends on a lot of other things. (Porter 1980, 363)

In view of these conditions the Boston matrix by itself is not very useful in determining strategy for a particular business (Porter 1980, 364) but it serves a component in competitor analysis and a company can plot a portfolio for each of the competitors.

At the height of its success, in the late 1970s and early 1980s, the growth share matrix (or approaches based on it) was used by about half of all Fortune 500 companies, according to estimates (Harpeslagh, 1982)

Boston consulting group has revisited this theory and proposes that a lot has changed since the 1970`s. The conclusion is that the theory still works but a company has to move through the quadrants more rapidly than before.

First, companies face circumstances that change more rapidly and unpredictably than ever before because of technological advances and other factors. As a result, companies need to constantly renew their advantage, increasing the speed at which they shift resources among products and business units (Reeves et. al., 2014).

Some researchers have pointed out weaknesses in the premises behind portfolio methods. In particular, they have addressed problems for the Boston Consulting Group (BCG) matrix (e.g., Day, 1986). The BCG matrix measures market attractiveness by market growth rate and it assesses the firm's ability to compete by its relative market share. The BCG matrix assumes a causal relationship between market share and profitability. Wensley (1981) argues that the BCG matrix lacks internal consistency; he also claims that there is little empirical evidence to support a causal relationship between market growth and profits. (Armstrong & Brodie, 1994, 3)

2.6.3 GE–McKinsey nine-box matrix

Another technique in positioning a company is a three-by-three matrix attributed to General Electric, Shell and McKinsey. The two axes in this matrix are attractiveness of the industry and the strength or the competitive position of the business unit. Where a business falls on the matrix there is a general need to invest to hold or improve a position or to harvest or divest from that position. Expected or unexpected shifts in business environment or business potential require that the position is re-evaluated constantly to keep up and ahead of the competition.

Porter states that much like in BCG matrix the tool offers again only “little but basic consistency check in formulating competitive strategy for the particular industry” (Porter 1980, 366).

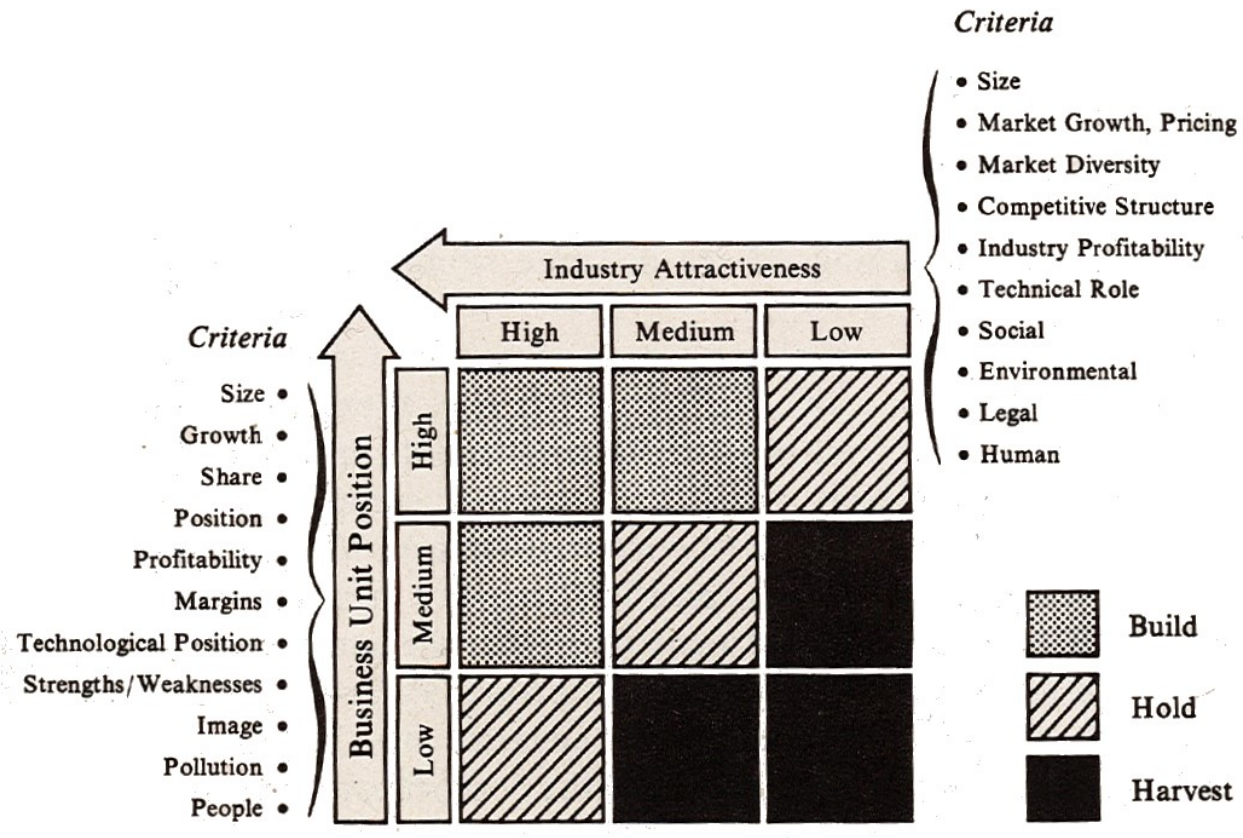


Figure 31 GE-McKinsey matrix (Porter 1980, 365)

Industry attractiveness indicates on the Y-axle how attractive the business will be for a company to enter or how easy or difficult it is to compete in the market and earn profits. The more profitable the industry is the more attractive it becomes. When evaluating the industry attractiveness, one should look at how an industry will change in the long run rather than in the near future, because the investments needed for the business or the product usually require long lasting commitment. Here are some of the indicators to look at according to Ovidijus Jurevicius (Jurevicius, 2014)

- Long run growth rate
- Industry size
- Industry profitability and market entry (use Porter's Five Forces analysis to determine this)
- Industry structure (use Structure-Conduct-Performance framework to determine this)
- Product life cycle changes
- Changes in demand
- Trend of prices
- Macro environment factors (use PESTEL for this)
- Seasonality
- Availability of labor
- Market segmentation

Along the X axis, the matrix measures how strong, in terms of competition, a particular business unit is against its rivals. In other words, managers try to determine whether a business unit has a sustainable competitive advantage or not. If the company has a sustainable competitive advantage, the next question is: "For how long it will be sustained? Here are some indicators to evaluate that:

- Total market share
- Market share growth compared to rivals
- Brand strength (use brand value for this)
- Profitability of the company
- Customer loyalty
- VRIO resources or capabilities (use VRIO framework)
- Your business unit strength in meeting industry's critical success factors (use Competitive Profile Matrix)
- Strength of a value chain (use Value Chain Analysis and Benchmarking)
- Level of product differentiation
- Production flexibility (Adapted from Jurevicius, 2014)

Later GE proposed to use a combined market and technology matrix. The principle of application is the same but additionally the technology portfolio addresses technology attractiveness and the relative technology position.

The relative technology position is based on the company's know-how background, as compared with that of its competitors, and the relative cost of promoting the technology. The order of technologies in the matrix is such that those marked by a higher degree of attractiveness and a higher relative position are assigned a higher priority. (Moehrle et. al. 2013

The integrated market-technology portfolio, proposed first already in the beginning of the 90s, is a combination of market and technology portfolios with the purpose to address market priorities (Roussel et al., 1991).

2.6.4 Contribution margin analysis

Contribution margin can be used as a simple portfolio tool or at least as the starting point for matrixes that aim to separate the stars from the dogs. Contribution margin analysis is a measure of operating leverage; it measures how growth in sales translates to growth in profits. Operating leverage is a measure of how revenue growth translates into growth in operating income. It is a measure of leverage, and of how risky, or volatile, a company's operating income is.

Contribution margin, or dollar contribution per unit, is the selling price per unit minus the variable cost per unit. Contribution represents the portion of sales revenue that is not consumed by variable costs and so contributes to

the coverage of fixed costs. This concept is one of the key building blocks of break-even analysis.

Contribution Margin = Revenues – variable expenses

In company internal calculations gross profit can indicate profitability within an account, a product group or a product. In the income statement the distinction between variable and fixed costs is lost so gross margin can no longer be calculated from financial information available. Inside the company it is still a viable method in comparing product or product group profitability.

Gross profit in general is not enough as a grading scale because the level is depending on the company`s fixed costs, investments and financing of the operating capital. A lower GP can indicate a weaker competitive position in terms of pricing or it can be used as a competitive advantage to gain more volumes. Which one it is, is usually revealed lower down in the statement. If growth is faster that relative competition then lower GP is probably a competitive tool.

It is quite easy to use this analysis to compare profitability between different customers in internal calculation. Of course, the margin is strongly related to business so it should not be used to compare companies, customers, product groups or products in different industries.

2.6.5 Arthur D. Little matrix

ADL matrix is the creation of Arthur Dehon Little in the late 1970`s. The matrix helps a business to plan its strategy based on competitive position, industry maturity with a 5 by 4 matrix respectively. The ADL portfolio management approach uses the dimensions of environmental assessment through competitive position and business strength assessment through industry maturity category.

Arthur D. Little built the strategic planning system around the concepts of market segmentation, the product life cycle, and competitive position. Segmentation suggests that a company should be divided into SBUs according to the industry segments in which they compete. ADL extended the product-life-cycle concept to encompass the evolution of a whole industry and its market, with the argument that a view broader than that of a single product is required to formulate a strategy for an SBU. Similar to McKinsey, the concept of competitive position covers more than market share alone. ADL has incorporated these extended concepts into a system for managing diversified corporations involving five sequential tasks:

1. Definition of SBUs
2. Classification of SBUs
3. Strategy development
4. Establishing priorities within the portfolio
5. Achieving objectives

When using ADL to product planning the industry life cycle stages are rather self-explanatory in the figure below. Competitive position can be summarized as follows:

- *Dominant* position is rare and often results from a near monopoly or protected leadership. In a dominant competitive position, one controls behaviour or strategies of other competitors. Can choose from widest range of strategic options, independent of competitors' actions.
- *A Strong* business can follow a strategy without too much consideration on mover from rivalling companies. A company can take independent stance or action without endangering long-term position. Can generally maintain long-term position in the face of competitors' actions
- *Favourable* industry is fragmented and no clear leader among rivals can be identified. Company has strengths which are exploitable with certain strategies if industry conditions are favourable. Has more than average ability to improve position. If in a niche, holds a commanding position relatively secure from attack.
- *Tenable* business has a niche, either geographical or defined by the product. Has sufficient potential or strengths to warrant continuation in business. May maintain position with tacit consent of dominant company or the industry in general but is unlikely to improve position significantly. If in a niche, is profitable, but clearly vulnerable to competitors' actions.
- *Weak* businesses are too small to be profitable or survive in the long term. They have critical weaknesses. Has currently unsatisfactory performance but has strengths that may lead to improvement. Has many characteristics of a better position, but suffers from past mistakes or current weaknesses. Inherently a short-term position; must change

Sometimes a *Nonviable* category is also mentioned. In that status a company has currently unsatisfactory performance and few, if any, strengths that may lead to improvement (could take years to die).

COMPETITIVE POSITION	INDUSTRY LIFE CYCLE STAGE			
	EMBRYONIC	GROWTH	MATURE	AGING
DOMINANT	▪ Fight for share ▪ Hold position	▪ Hold position ▪ Hold share	▪ Hold position ▪ Grow with industry	▪ Hold position
STRONG	▪ Attempt to improve position ▪ Fight for share	▪ Attempt to improve position ▪ Push for share	▪ Hold position ▪ Grow with industry	▪ Hold position or harvest
FAVORABLE	▪ Selective or fight for share ▪ Selective attempt to improve position	▪ Attempt to improve position ▪ Select push for share	▪ Custodial or maintenance ▪ Find niche and attempt to protect it	▪ Harvest or phased withdrawal
TENABLE	▪ Selectively push for position	▪ Find niche and protect it	▪ Find niche and hang on, or phased withdrawal	▪ Phased withdrawal or abandon
WEAK	▪ Up or out	▪ Turnaround or abandon	▪ Turnaround or orphaned withdrawal	▪ Abandon

Figure 32 ADL matrix (Little 1974)

Above is the adaptation of the "strategic guidelines as a function of industry maturity and competitive position"

The primary limitation of the ADL approach is that it is sometimes seen as being deterministic. That is, the assumption that "strategy is condition driven" and not ambition driven seems to suppose that good strategy is not driven by passion or emotion and that strategies can be reduced to 25 alternatives that should fit certain conditions as defined by industry maturity. Although clearly not as severe as BCG's deterministic approach to strategy, some observers have wondered how the role of creativity might better be brought into the strategic management process.

2.7 Portfolio model conclusions

How each of the matrix originating firms works with a customer (Adapted from Bourgeois III, 1988)

1. BCG: Treats the development of business strategy as a problem that can be researched, mainly by examining economic, financial and marketing data. These data are sorted and understood by using a number of business strategy concepts (experience curves, growth share matrices, sustainable growth formulas, and so forth).
2. McKinsey: Uses concepts similar to BCG's, but gives greater emphasis to a participative approach in working with its clients.
3. ADL: Assumes that much of the knowledge and skill a firm needs to prepare its business strategy is held by the company's mid- and upper-level managers. The job of the consulting firm is to help identify these managers and then train them in the techniques needed to do strategy

planning. The consultants will often manage the actual meeting to help facilitate the surfacing of information and the making of decisions.

Basic features of each approach

1. BCG: Team of BCG consultants acting as outside researchers, data from client and industry sources, and extensive use of BCG's concepts to alter the client's perspective.
2. McKinsey: Team of McKinsey consultants frequently on site, data from client and industry sources, uses strategy concepts similar to BCG's, but often uses organization studies to complement the economic analysis aspects of strategic planning.
3. ADL: Profiling group processes facilitated by ADL consultants, analysis based largely on data provided by the client, analysis intended to give the client's managers a new, common language to think about strategic decisions.

Whichever portfolio tool is selected for the case company it will a common platform to talk about the different product development initiatives and compare their impact on the market position and on the business performance of the SBU. The McKinsey matrix seems to offer the most versatile tool of these three alternatives and invites to consider competitive factors outside just product features and how they are seen to be placed in competition.

3 SELECTING THE TOOLS FOR THE CASE COMPANY STRATEGY PROCESS

Having researched the methodologies, taking into account the previous research (Korhonen, 2014) and considering the operational and business framework of the case company the researcher has selected the methods from the *foresight diamond*, approaching the SMART triangle from the *outcomes direction* and applying the *Futures radar* from Korhonen (Korhonen 2014, 93)

Futures radar is proposed working model that could be a basis for an effective weak signals capture and futures anticipation framework for the case company. This model places a firm in the epicentre of the SECI-model and encompasses the organizational learning, weak signals capture and facilitates tacit knowledge emergence in the organization. It includes the discipline in the organization wherein the activity takes place. Through the cycle of information gathering, internalization and socialization the organization is implanted in a learning loop that is driven by strategy. That is the case if the company is in a development phase where strategy drives the tactics and actions. If the company is in a phase where strategy needs rework then the input to it can come from the process. (Korhonen 2014, 93)

Figure 33 Foresight framework for the case company

A bigger and better legible picture of the selection and the future radar process can be found in the annex 1

The futures tool results are in the next strategic phase combined with the well-known *SWOT* analysis and *PESTEL* analysis. This is done in the company case for a scenario where the future is a case of CLEAR or ALTERNATE FUTURE. This assumption is not taken at random but based on a strong experience that the industry in question does not easily adopt the latest technology but instead is known for beeing very slow moving regarding adopting new technology and prefers it to be well proven in use in some other industry before embracing it. Therefore the future is reasonably well predictable and since the end products that will house the products made by the case company have a life cycle of 30 or more years they are clearly investment commodities by nature. In addition to beeing investments they come with a high price and usually the infrastructure is owned by governments and the rolling stock fleets are owned by asset management companies so it implies that future must be quite clear before such investments are made.

Foresight part research indicates that the use of quantitative as well as qualitative methods should be applied and therefore the researches assumes based on data that has some longitudinal qualities that the market is on a linear growth curve of approximately 3% per year based on research data that is explained in chapter 4.4

Figure 34 Workshop methods for the case company

For workhop strategic methods for the case company the researcher selected standard PESTEL, SWOT and clear or alternate futures.

For product portfolio and market positioning the researcher selects well-known models that on the surface seem outdated but serve the purpose well if applied in a cross-disciplinary way. In this case there is a an adaptation in the use of the GE-McKinsey matrix. Instead of looking at a complete business unit level attractiveness it is use to look at the product portfolio of the customer and determine if the suppliers product offering is catering to those platforms and if so is it worth doing which is leading to a desicion of retiring that product line, holding it and making it a cash cow or trying to grow its importance by developing it further.

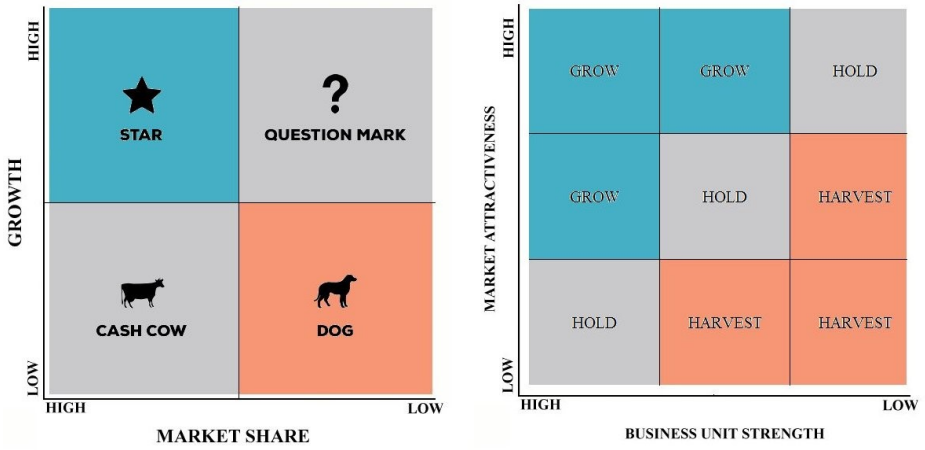


Figure 35 Methods developed for product positioning for the case company (Korhonen 2018)

It is apparent that due to the complexity of the business area and lack of properly reliable trends that could be utilized the emphasis in this the methodological choice will be on methods based on expert knowledge. Those methods combined with efficient work group and road mapping should cover the case company of many challenges and help it prepare for the future competition and emerging phenomenon. Futures work done well with established tools and proper work attitude harboured by attentive management should also facilitate road mapping and creation of product portfolio to support R&D investment and scares resource allocation in the stable markets that is not easy to enter but is tempting new entrants by its stability.

4 APPLYING THE TOOLS ON THE CASE COMPANY

This chapter applies the selected tools and aims to explain some of the business drivers that impact the case company operating in Finland and working in mass transport second tier level. The view point is from within the railway industry.

Pestel factors are global in nature so looking at them on a company level is not applied. The viewpoint is more on the accessible market where the company can compete against its rivals and how Pestel factors places the

case company in the market place when it is operating from Finland. The researcher cannot go to the market, interview all its competitors and customers and study the existence of the megatrends and Pestel drivers so the application chapter is also filled with references from literature enriched with comments and observations based on the long experience of the researcher working in the railway industry.

In a situation where the case company is working in a niche market that is mature and the market share is over 35% the only way to keep competitive outside acquisitions is to keep innovating and improve the product offering and efficiency of operations. In SME`s the typical battle in reference to product development is the use of the same resources for customer service and design versus the long-term product development.

With a history of more than 175 years, the rail supply industry is one of the backbones to European industrialization and economic development. It has catered to European integration by connecting European states and citizens in an environmentally friendly way. Today, rail industry is more dynamic, innovative and important to the European economy than ever before. Rail industry is now at a pivotal moment where the industrial competition from Asia, especially China, is becoming increasingly intense. There is also the need to enhance the internal EU market for rail supplies, ensuring fair market access to European rail suppliers abroad and boosting export potential. Improving the business environment for rail supply SME`s is also required as well as stimulating the demand for rail projects both domestically and abroad through pro-rail policies, financial instruments and funds. Innovation plays an important role in remaining competitive both for SME`s and OEM`s.

The commercial transportation industry is facing perhaps the most radical technology-inspired indirect change in customer behaviour. Manufacturers, the sector’s biggest customers, are rapidly adopting 3D printing, which lets companies produce finished goods from a single piece of equipment and minimal amounts of raw material, rather than assembling them from dozens, hundreds, or thousands of parts procured globally.
According to Rothfeder the implication is dramatic: As the need to purchase parts from multiple global sources diminishes, component and materials shipments, a substantial portion of the commercial transportation sector’s revenue stream, will be greatly reduced. Rothfeder proposes that in fact, as much as 41 percent of the air cargo business and 37 percent of the ocean container business is at risk because of 3D printing. Roughly a quarter of the trucking freight business is also exposed, owing to the potential decline in goods that start as air cargo or as containers on ships and ultimately need some form of overland transport. (Rothfeder, 2015)

4.1 Key PESTEL drivers

The researcher has picked up some of the themes depicted in figure 53 below and phenomenon that are relevant for rail environment from a road mapping initiative that was sponsored by the UK Department of Trade and Industry, and the process facilitated by Robert Phaal (Phaal 2002). The in-

formation contained in the report was based on a series of ten workshops that brought together more than 130 experts from across the road transport industry. More than 60 organizations were involved, including industry, academia and Government.

The focus of the technology roadmap was the road transport vehicle of the future, linking ongoing research programs and technology developments to innovative products and systems. Rail transport was featured in the initiative to some extent and the PESTEL items have been picked up into the chart below. Only the ones that seem relevant to the case company product offering and business have been selected. The starting point and length of the arrow does not necessarily reflect the starting time or ending of the depicted phenomenon.

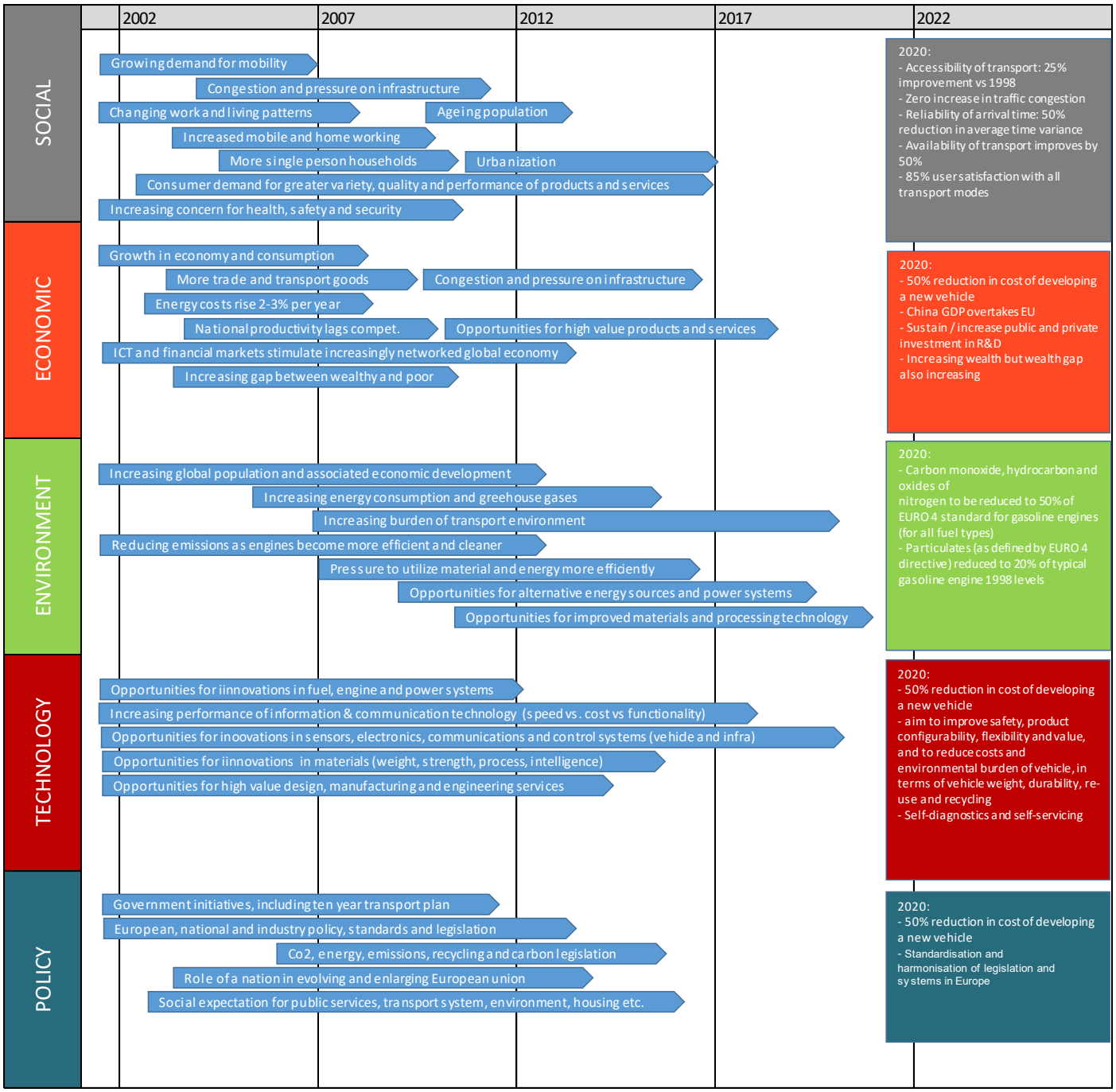


Figure 36 Industry and market trends and drivers (adapted from Phaal 2002, 10)

It is apparent that many of the general Pestel and megatrend factors have an impact on the market and technologies that are applicable for the case company. It gives an indication on which technologies and product features are favourable. The following Pestel is seen from a viewpoint that the individual factors drive the market which drives the need for products that are in line with the factors. That in turn is translated by the individual companies into feasible solutions to those problems by a selection of technologies that are available to the company and feasible in the products and services the company offers to its customers.

Considering the transportation specific Pestel was made in 2002 and just picking one visionary factor from each Pestel area it is apparent that a company could have directed its product development in a direction where it is competitive in terms of product features and technologies. Now in 2018 urbanization as a phenomenon continues to drive growth in transportation sector, rising energy cost prefers technologies that improve energy efficiency, emissions are more and more regulated and new weight saving technologies contribute to less weight and therefore energy efficiency.

4.2 Megatrends

PESTEL factors are inevitably global in nature and can also be megatrend like when they are strong enough. John Naisbitt is considered the father of megatrend analysis because of his book in 1982 called Megatrends. Megatrend is a global phenomenon that changes the fabric of societies. It proceeds relatively autonomously and the root cause is often hard to find. Businesses, companies and individual people may find a megatrend to be an inevitable change agent that has considerable impact on national and international trade and societal structure.

Mika Mannermaa (2000) considered these as megatrends:

1. Globalisation: attitudes, markets, production processes, economy
2. Networking: companies, governments, citizen, real-time
3. Sustainability: ecologically and socially
4. Transformation of work: From industrial society to information society
5. Public sector role: control, self-service, monitoring of fundamental rights
6. Aging population: baby boomers, young people (adapt, marginalized)
7. Cultural exclusion: mental hospitals, prisons, drugs, criminal offense, religious extremism
8. Technological evolution: ICT, new materials, biotechnology, energy technology

Looking at the case company`s key customer strategy statements all of them listed population growth, mass urbanization and environmental sustainability as their market drivers. Fifty percent listed changes in public funding, market liberalization or market regulation and inter-modality as additional drivers.

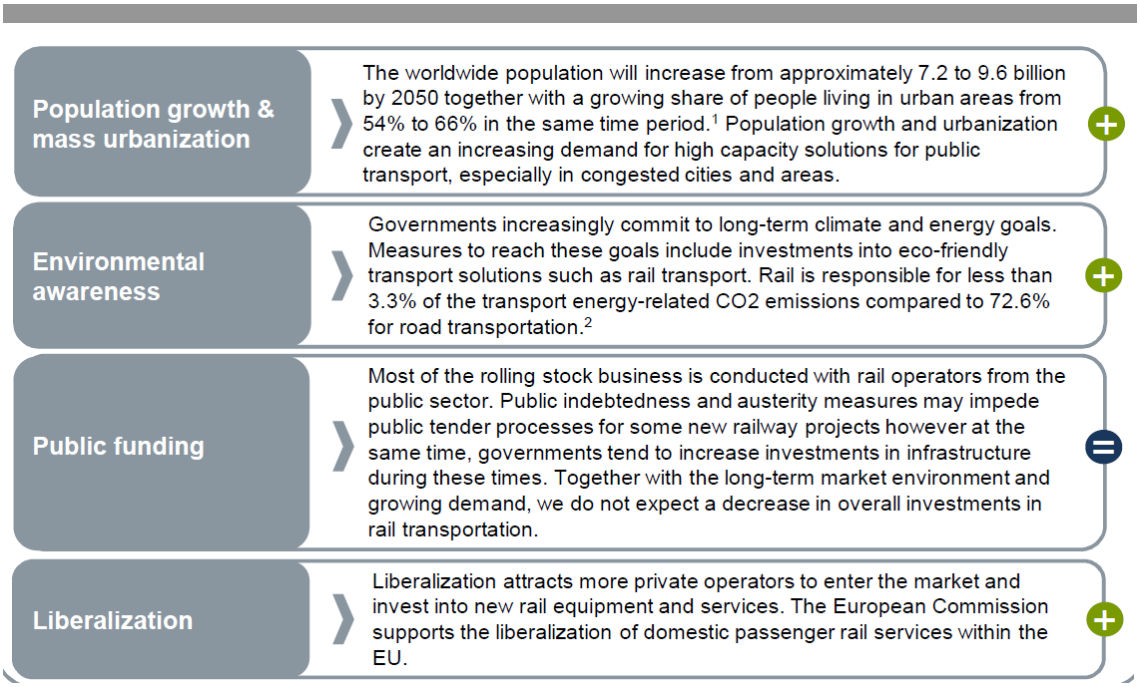


Figure 37 Global rail market drivers (Bombardier, 2015a)

As an example, Bombardier transportation, the 3rd largest manufacturer of new rail vehicles mirrors the same main drivers for the growing need for new rolling stock. Many other customers of the case company have the same main drivers listed in their strategies and websites.

4.3 Case company PESTEL P-factor, Political

The existence of Pestel political factor should be looked at on a global level. How a company performs in global competition partly depends on how countries compare to each other in the global competition as the best environment to conduct business. There is depiction of Finland in comparison to other countries in the next chapter of technology comparison. This global competitiveness index takes into account many factors that constitute the ability to be competitive as a business environment. The political factors in Pestel analysis fall within tax policies, employment laws environmental regulations and societal freedom from regulation. In the area of labour and tax policies Finland currently suffers from inflexibility in restrictive labour regulations, high tax rates and tight tax regulation among other things.

Transportation can be divided into four principle forms: automotive, rail, shipping and aviation. The automotive industry is already frantically moving away from its reliance on fossil fuels, with innovations in fuel economy and electric and hybrid cars which are promised to be affordable to 30% of road users within the next 15 years. The rail industry is also leading the way in environmentally sustainable innovations, and an ideal alternative to road transportation. The statistics backs up the expectation that rail would play a significant role in adoption of the COP21 Paris convention on climate change agreement proposal draft decision CP.21 and rail, in its many forms, is the most environmentally friendly form of transport. There is an expectation that world leaders would formally agree to assist a

modal shift towards rail as a primary source of transportation for passengers and land freight. This constitutes a strong political factor that speaks for a good future for the industry that is more environmentally friendly compared to other forms of motorized transport.

4.4 Case company PESTEL E-factor, Economic business growth in the industry

The existence of Economic factors and indicators should also be looked at on a global level. How a company performs in global competition strongly depends on how the business is growing globally and countries compare to each other in the global competition in market growth and if the countries are so called accessible markets to the case company.

Unlike other indices (such as the World Competitiveness Index), the GDI Global Dynamism Index does not provide an absolute measure of the economic growth environment but rather, through a combination of 'static' (e.g. corporate tax burden) and 'dynamic' (e.g. real GDP growth) indicators, it highlights the potential for business growth in each market.

However, some economies do perform consistently well: the top five in GDI 2015 all appeared in the top ten of the GDI 2013. Their performance indicates true dynamism - an ability to renew and develop their business growth environments to stay ahead of the curve.
While emerging economies largely powered the global recovery as governments, businesses and consumers deleveraged in the developed world, many have now started to slow. For the leaders of dynamic businesses searching for international growth opportunities, this presents a challenge.

The figure below depicts Real GDP growth, Real private consumption per head, Change in dollar value of stock market index.

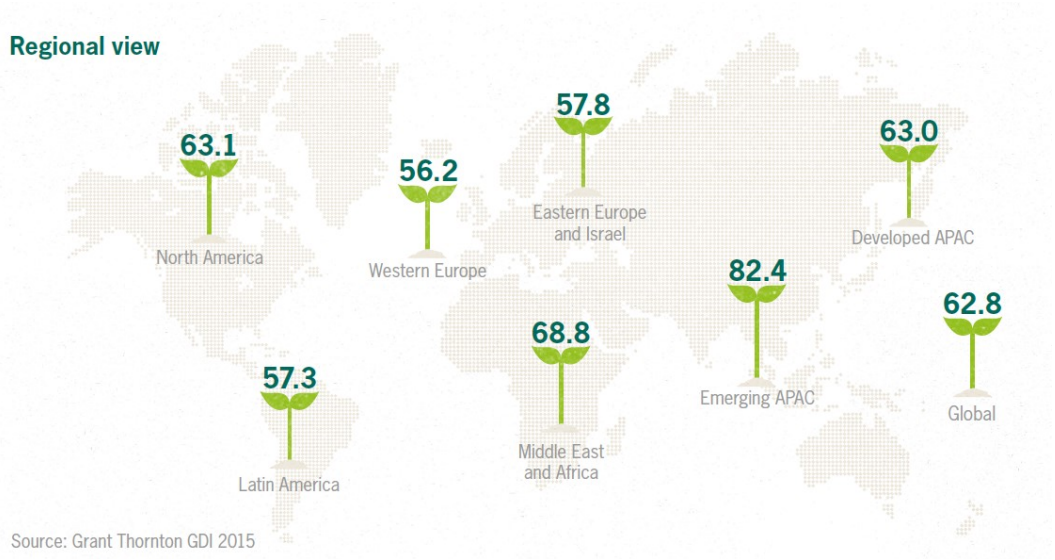


Figure 38 Market growth, regional view (GDI, 2015, 15)

Marketline (Marketline 2015) forecasts a business specific growth for the railway industry on a compound average of 4,3% with the balance slightly

on the freight side of traffic. The megatrends are positive with organic growth forecasted for several years. The perception of outlook matches the past development which leads to believe this is a good business to be in with moderate growth expectations. Focus of the markets might shift slightly from Euro-zone to APAC and North America and urban rail is expected to be the provider of growth opportunities above average.

Year	€ million	% Growth
2011	305,078.6	
2012	322,436.8	5.7%
2013	337,252.3	4.6%
2014	353,990.9	5.0%
2015	360,856.8	1.9%
CAGR: 2011–15		4.3%

Figure 39 Global railroads sector value (Marketline 2015, 8)

Year	€ million	% Growth
2015	360,856.8	1.9%
2016	382,589.7	6.0%
2017	401,950.1	5.1%
2018	420,722.0	4.7%
2019	443,724.6	5.5%
2020	468,651.5	5.6%
CAGR: 2015–20		5.4%

Figure 40 Figure 37 Global railroads sector value forecast: € million, 2015–20 (Marketline 2015, 11)

Geography	%
Asia-Pacific	42.3
Europe	30.6
United States	20.9
Middle East	0.1
Rest of the World	6.2
Total	100.1%

Figure 41 Global railroads sector geography segmentation, 2015 (Marketline 2015, 10)

Category	%
Passenger Rail	52.4%
Rail Freight	47.6%
Total	100%

Figure 42 Global railroads sector category segmentation, 2015 (Marketline 2015, 9)

Looking at Europe in order to compare the relative importance of rail transport between EU27 countries, the data of modal split of inland passenger transport can be normalized by expressing the level of passenger traffic in relation to population. According to Eurostat (Eurostat 2015, 109) on average each inhabitant of France, Sweden, Austria, Germany and Denmark travelled more than 1000pkm in 2013 on the national railway network; this was well below the average recorded in Switzerland (2141 pkm per inhabitant in 2013). By contrast, among the EU Member States in 2013 the lowest average distances travelled on national railway networks were recorded in Lithuania (85 pkm per inhabitant) and Greece (75 pkm in 2012), while the averages in Turkey (49 pkm) and the former Yugoslav Republic of Macedonia (39 pkm) were lower still.

It would appear that societal development and environmental awareness matches modal split between car, bus and rail. Of course, tradition, attitudes and quality of rolling stock bares significance as well. Any causality needs to be studied further but there seems to be some correlation.

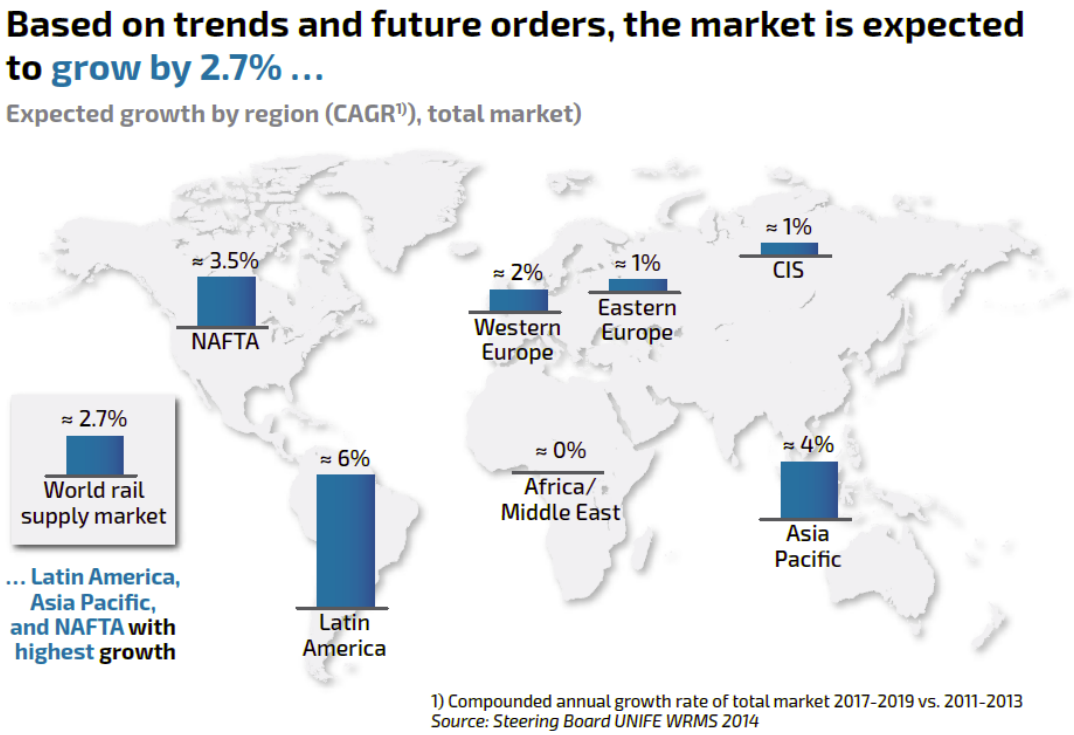


Figure 43 Compound annual growth rate of the market (Unife 2014a, 43)

UNIFE is representing the European rail manufacturing industry in Brussels since 1992. The association gathers over 80 of Europe's leading large and SME rail supply companies' active in the design, manufacture, maintenance and refurbishment of rail transport systems, subsystems and related equipment. UNIFE also brings together 15 national rail industry associations of European countries. UNIFE advocates its members' interests at both the European and International level—actively promoting EU rail equipment and standards within Europe and abroad.

Unife`s market forecast is the most quoted and trusted in railway industry publications and strategy presentations at investor events of the largest manufacturers. In 2014 Unife has forecasted a compound annual growth of 2,7% for the global market with Nafta and Asia Pacific as the main drivers. A 2016 study forecasted a compound annual growth of 2,6% for the global marker with Western Europe, Africa and Middle-East leading the way (Unife 2016, 6-33).

In the study published 2016 the forecast average between SCI and Unife was exactly the value witnessed during the forecast period. The overall rail supply market has witnessed a substantial growth at 3%, driven for the main part by the Asian Pacific region (Unife 2016, 6).

SCI (SCI Vehrker 2014b) states that urban rail is the most dynamic rail segment worldwide with main drivers of growth: urbanization and expansion of infrastructure and numerous important new infrastructure projects in Africa/Middle East and Asia. Highest growth rates are expected in Asia, Africa/Middle East, and South/Central America. Eastern Europe and CIS

are to reverse historical performance decline along with consolidation of Chinese leadership. Most dynamic growth expected for South/Central America.

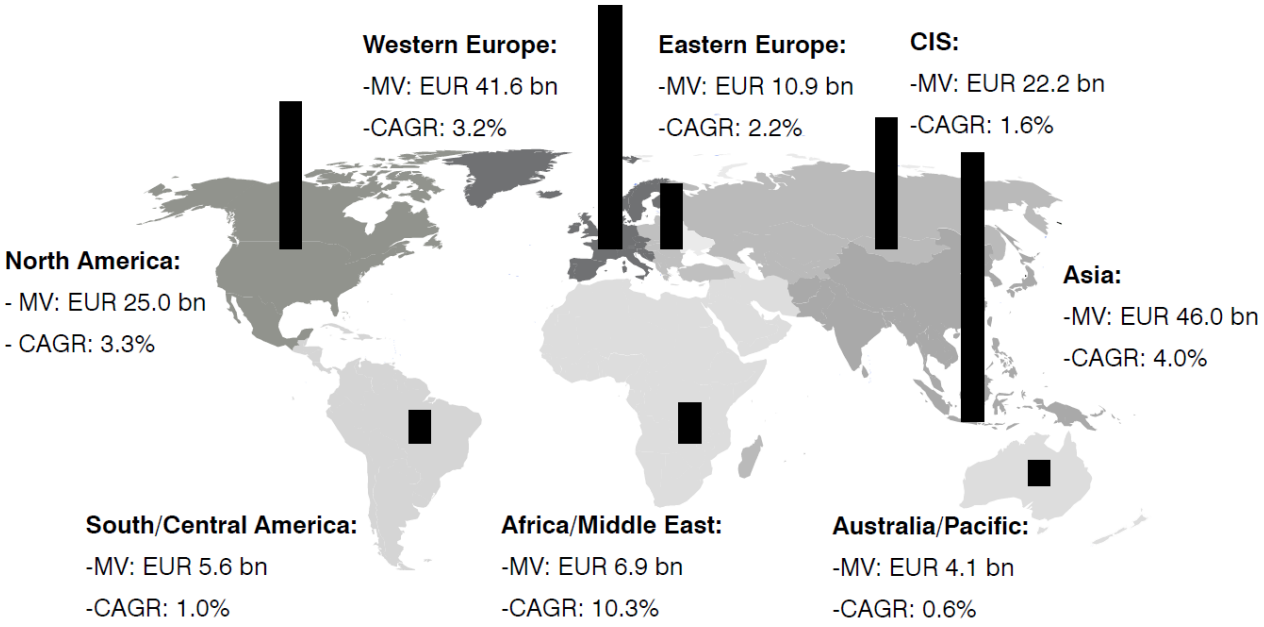


Figure 44 Market volume 2013 and market development in the period up to 2018 (CAGR) by regions (SCI Vehrker 2014b, 13)

Unife and SCI estimates vary somewhat but the 2 main markets for growth are clear: North America and Asia/Pacific. Global market for railway technology is at the level of 162 billion Euros and Rolling stock represents 60% share of the total market.

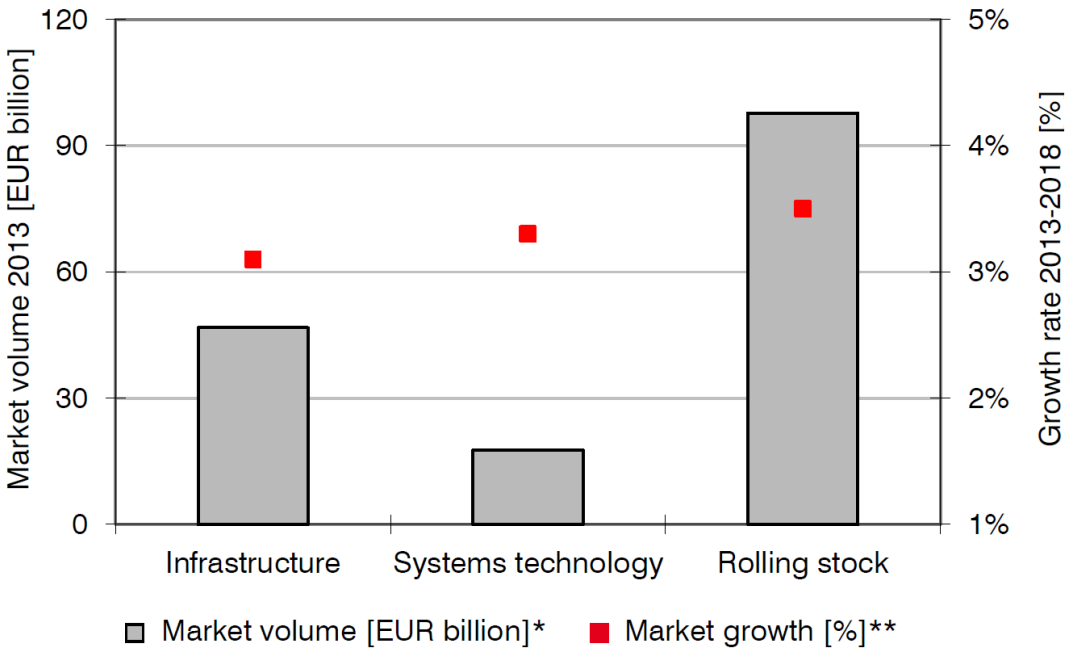


Figure 45 Market volume and market growth by product segment [2013, EUR billion/2013-2018, %] (SCI Vehrker 2014b, 14)

A slight 3.4% annual growth is foreseen (SCI Vehrker, 2014) until 2018 (including increase in prices) for all three segments with long-term development with a positive outlook due to urbanization, climate and environmental targets and Increasing demand for resources. Urban rail remains the most dynamic segment of global rail market. Urban rail has been the driver of growth for the global rail market due to bad traffic situation in cities leading to long-term, stable growth. Conventional rail has investments mainly driven by new freight lines and existing networks and high-speed rails overall market volume is declining despite various large investment projects.

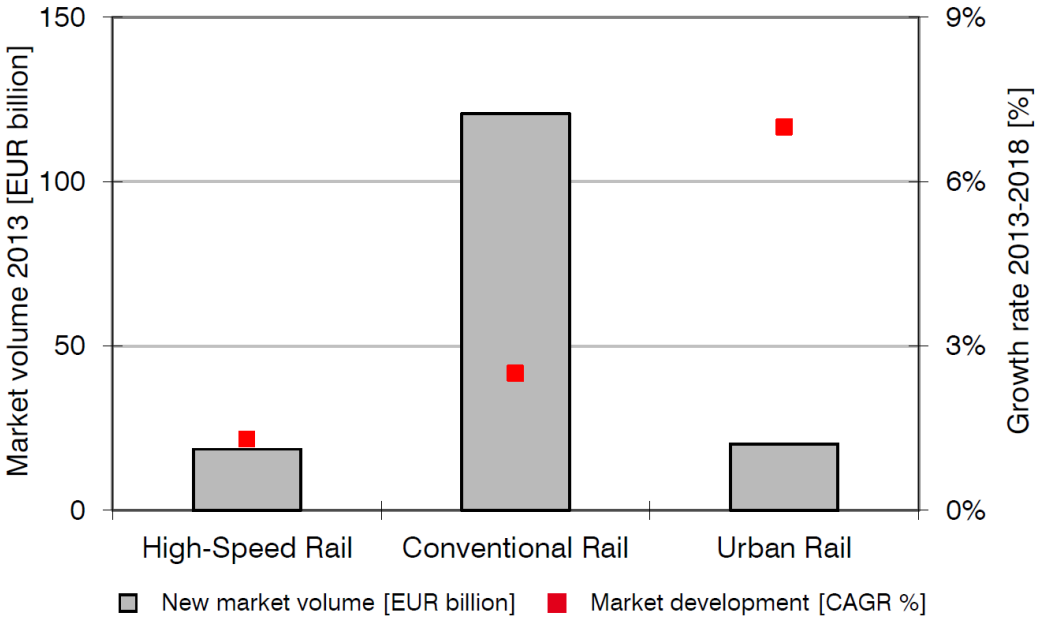


Figure 46 OEM market volume and market growth by transport segment [2013, EUR billion/2013-2018, %] (SCI Vehrker 2014b, 15)

The future of urban mobility 2.0. Arthur D. Little Future lab study for UITP International association of public transport depicts the growth of investments in to the urban mobility business.

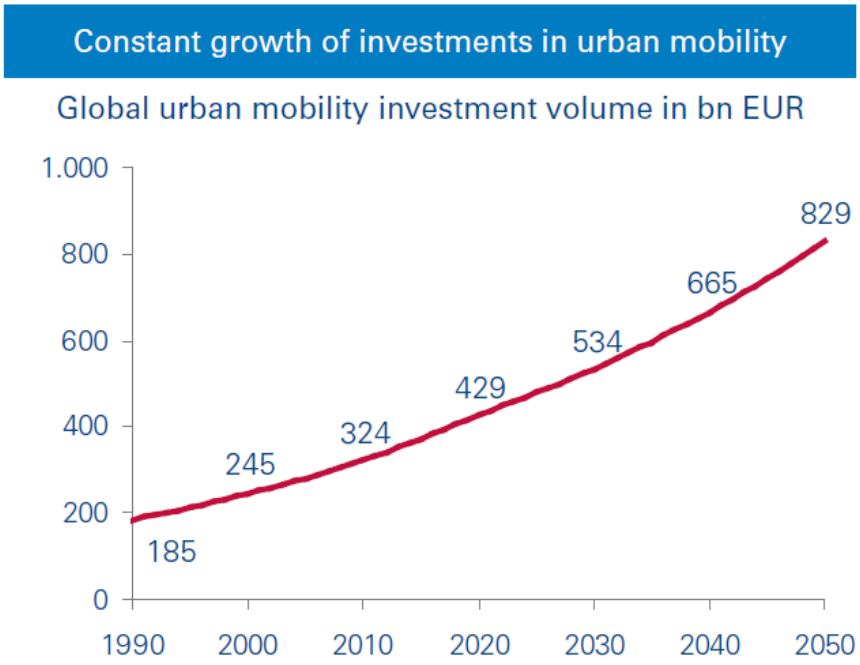


Figure 47 Growth of investments in urban mobility (Little, 2014, 10)

SCI Vehrker`s indexed urban rail performance curve indicates a strong growth pattern for urban rail performance on the long term.

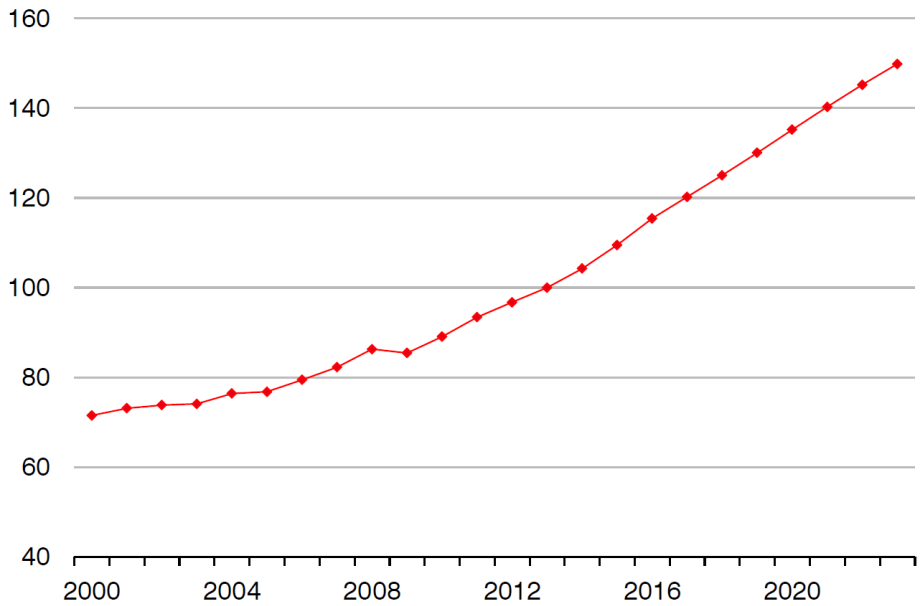


Figure 48 Worldwide urban rail performance 2000-2023* (indexed, 2013 = 100) (SCI Vehrker 2014b, 20)

Urban rail transport is forecasted to grow strongly with funding situation vastly improved due to its strategic importance to metropolitan areas. Urban rail transport will show strongest growth in upcoming years. Important drivers of urban rail include increasing urbanisation and concentration of housing in large cities, growing demand for efficient transport

mode to counteract road congestion, green idea/sustainability increasingly funded extensively with strongest dynamics in developing countries (Asia, Middle-East and South America).

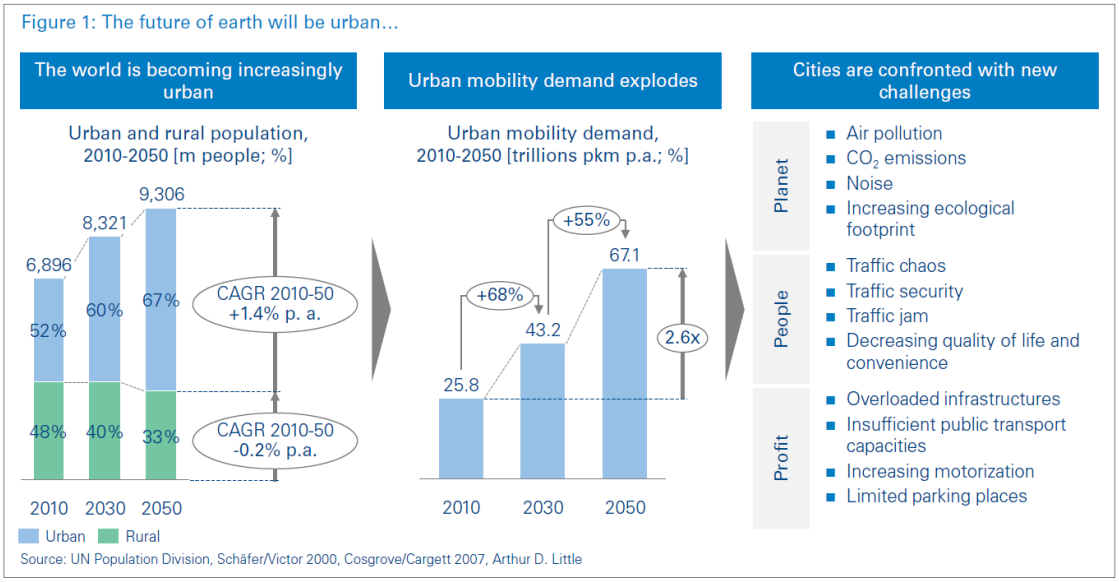


Figure 49 The future of urban mobility 2.0 (Little, 2014, 9)

The Arthur D. Little Future lab study for UITP International association of public transport Shows the biggest growth in demand for urban mobility and features some of the root causes that drive that demand

It is noticeable that three different independent research companies forecast the same positive development for railway market.

In countries` railway rankings China is number one with Spain as the only country with negative growth rate. Chinese rail market continuously at very high level. After-sales market will increase rapidly with established stock along with a focus of market volume to shift from high-speed rail to intercity, urban rail and freight.

Top 3 countries in investment are China, USA and Russia. European markets stabilized by investments that are strongly depending on public spending with a positive trend noticeable. Spain is the only market with negative growth expectations due to high level of immigration. Geopolitical instability in various regions could reverse respective market outlooks. Focus of Chinese players is to gradually shift to export markets (future overcapacities). Also in other established markets, demand for railway technology products is under pressure, resulting in strong export focus (and competition).

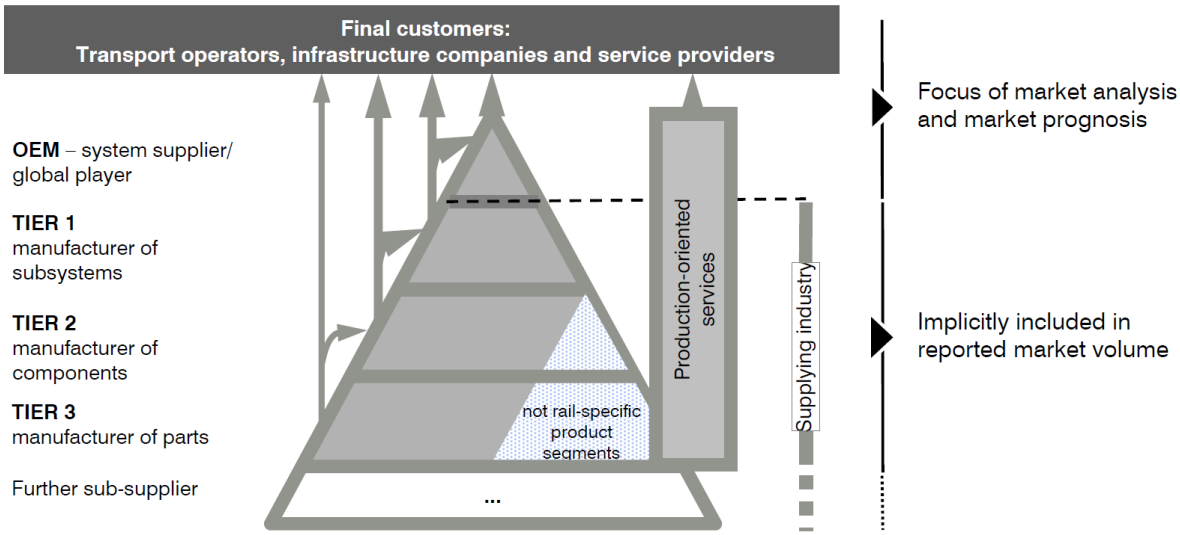


Figure 50 Generic value chain in the rolling stock industry (Korhonen 2016)

Relatively small margins are a common feature of global players in final manufacture step which is opposite to the niche products in tier 2-3 levels. There is constant discussion and even activities taken last year in concentration of the manufacturing panel at OEM`s and staff reductions. The high-end cost of a one-off design, capacity at the production sites and homologation is a challenge. Evolvement of trends especially in passenger transport requires geopolitical stability with minimal terrorist threat and economic prosperity to build the infrastructure required.

The industry is met with a challenge of applying strong efforts to regain efficiency and cut costs. Mergers and strategic cooperation can provide relief of current and potential future pressure. Identification and development of reliable international market through strong partnerships both upstream and downstream with local players in addition to home market is a pre-requisite for success.

4.4.1 Relevant market size for the case company

Based on the forecast of organic growth in chapter 4.4 the railway market and especially rolling stock market is at a mature state and some growth occurs but it is relatively moderate. When looking at it from a company perspective the company has to look at the accessible market that is relevant for the product offering.

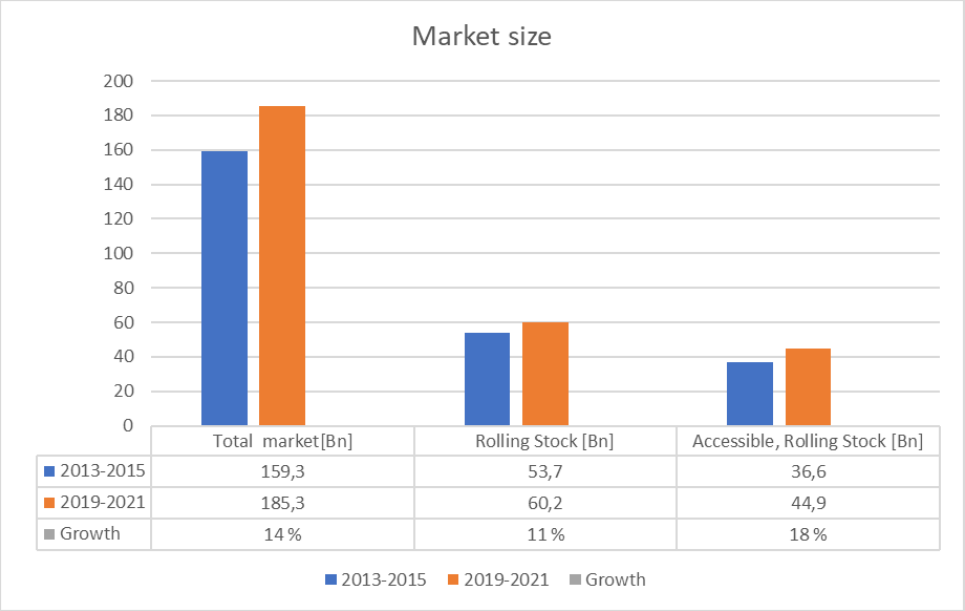


Figure 51 Rolling stock market size forecast (Adapted from Unife 2016, Mika Korhonen 2018)

Roland Berger strategy consultants have studied the market for Unife and the picture above depicts that the accessible market in rolling stock is exceeding 40 billion Euros. This increase is predicted to be driven to a large extent by the growth in the multiple units' segment in the future market. However, the overall demand for locomotives, coaches, and wagons is foreseen to decrease slightly between 2019 and 2021. This decline is understandable given the high volumes for locomotives and freight wagons in the current market period until the end of 2018.

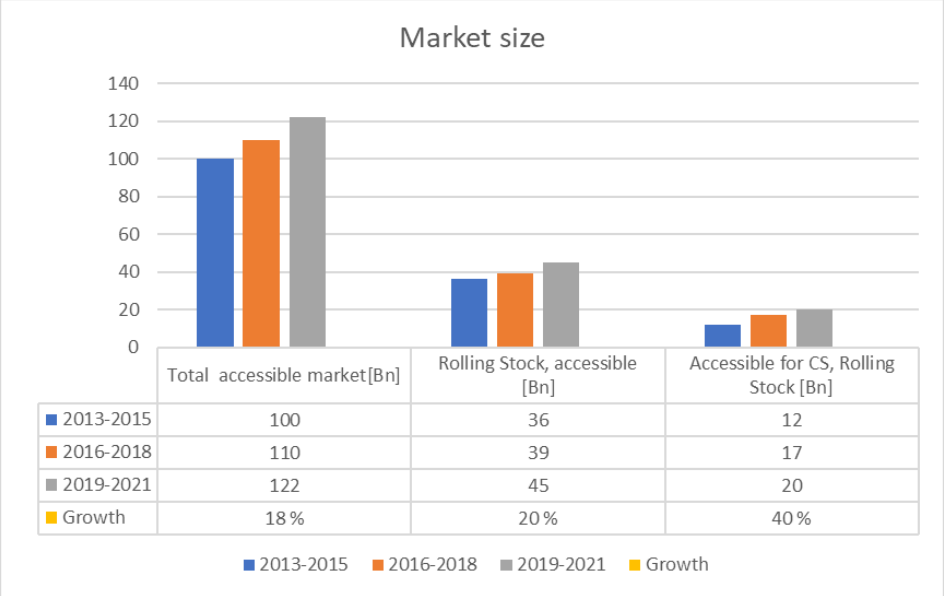


Figure 52 Rolling stock market size forecast (Adapted from Statista 2018, Mika Korhonen 2018)

Statista (Statista 2018) agrees with the market forecast but offers a division into different fleets allowing to forecast market access for the case company (Accessible, CS) based on the product platforms where they are present in the market.

4.5 Case company PESTEL S-factor, Social

Social factors in the business area of case company are urbanization, population growth and lifestyle choices of people needing transport. While the world speaks of mobility as a service and on-demand door-to-door means of transport it is evident it will take time before all the systems are in place and in addition to legal environment also the social acceptance is there to facilitate this model change and take people towards an efficient intermodal system that utilizes the existing infrastructure and is supported by the readily available and affordable on-demand services.

4.5.1 Urbanization

Urbanization is the main driver in countries when they are considering how to develop their mass transport strategies. Given the rate of urban growth in developing nations and the early stage of their infrastructure development efforts, according to WWF, it can be concluded that they can offer the highest returns in the quest for urban sustainability, even if they are currently less equipped to deal with the challenge. Given the outsized energy usage of cities in developed nations, it is also clear that developing nations should not adopt their inadequate transportation systems and energy-wasting house and building stock as a norm. Instead, developing nations must be supported in a drive to minimize energy use and undertake a shift to renewable energy sources that will enable low-carbon lifestyles for city dwellers. (WWF 2012, 5)

World Bank statistics explains rural population so that it refers to people living in rural areas as defined by national statistical offices. It is calculated as the difference between total population and urban population. Aggregation of urban and rural population may not add up to total population because of different country coverages.

Urban concentration is a fact, and as city life becomes a reality for an ever-increasing share of the world's population, governments, companies, and society must recognize that they are largely unequipped to deal with city-level problems.

Africa and Asia are urbanizing more rapidly than other regions of the world. The rate of urbanization, measured as the average annual rate of change of the percentage urban, is highest in Asia and Africa, where currently the proportion urban is increasing by 1.5 and 1.1 per cent per annum, respectively. Regions that already have relatively high levels of urbanization are urbanizing at a slower pace, at less than 0.4 per cent annually (United Nations, 2014, 8)

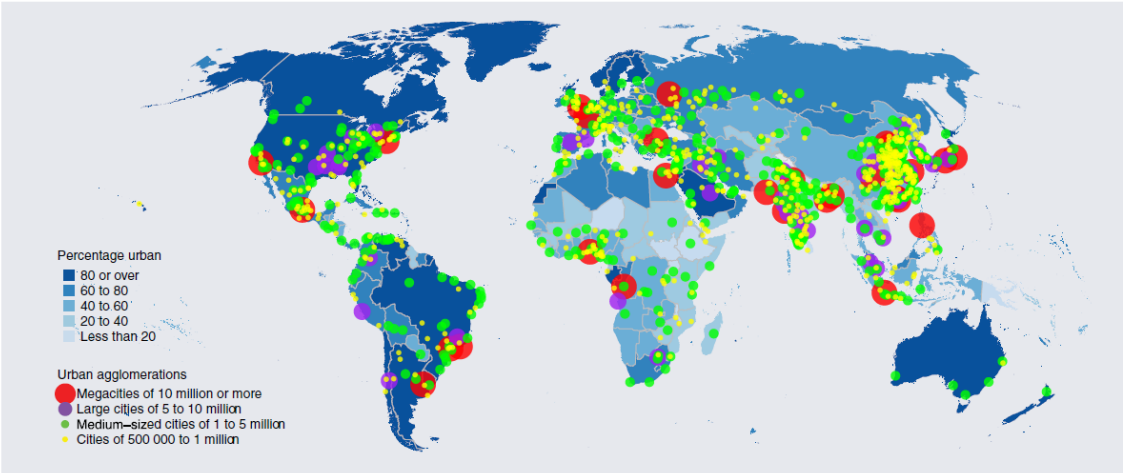


Figure 53 Percentage urban and location of urban agglomerations with at least 500,000 inhabitants, 2014 (United Nations, 2014, 9)

Globally, more people live in urban areas than in rural areas. In 2007, for the first time in history, the global urban population exceeded the global rural population, and the world population has remained predominantly urban thereafter. In 2014, 54 per cent of the world's population is urban.

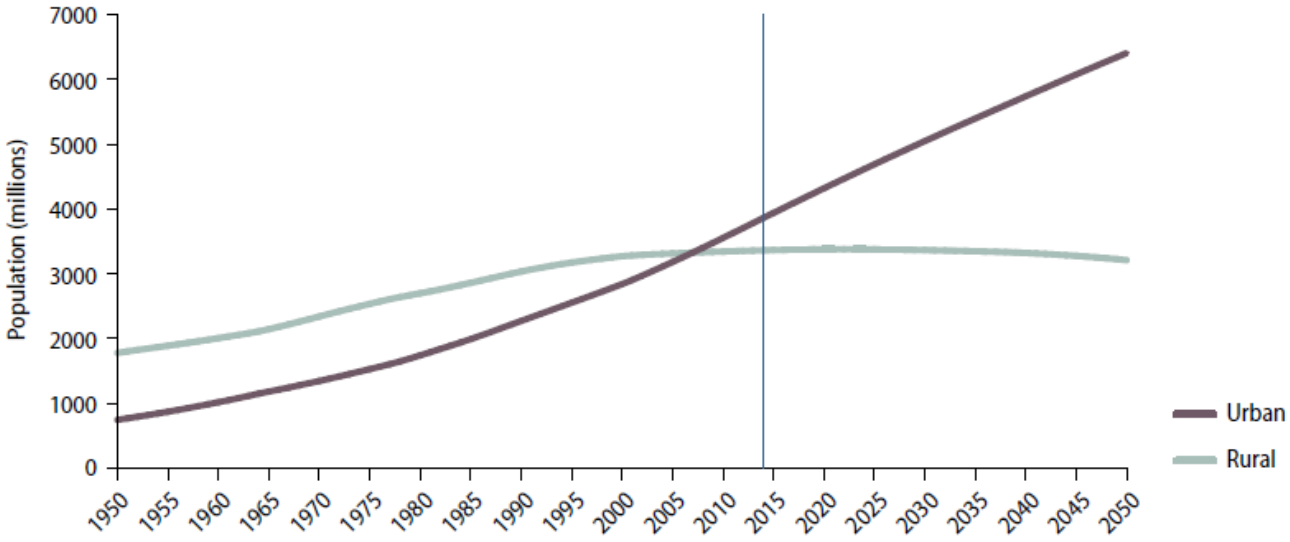


Figure 54 Urban and rural population of the world, 1950–2050 (United Nations, 2014, 7)

The urban population is expected to continue to grow, so that by 2050, the world will be one third rural (34 %) and two-thirds urban (66 %), roughly the reverse of the global rural-urban population distribution of the mid-twentieth century. (United Nations, 2014, 7)

4.5.2 How urbanisation and increased income impacts choice of transport

As the world becomes increasingly urban, densely populated areas will face dramatic and seemingly intractable transportation issues. Fifty percent of the global population already lives in cities and, according to the United Nations, that number will approach 70 percent in the next 40 years. If current trends continue, people's reliance on cars will only increase, particularly in emerging markets. As the growing population becomes more affluent, the number of vehicles on the road worldwide is projected to triple, to as much as 3 billion by 2035, according to economic forecaster company Global Insight. A good deal of this increase will be due to magnified urban sprawl; many already overcrowded cities won't be able to simply build up to accommodate new residents, so they will have to stretch their borders and build out.

And as the traffic jams worsen, much more than time will be lost. Vehicle congestion typically erodes a country's GDP by 1 to 3 percent. And the pollution, noise, accidents, and altering of the landscape attributable to cars and roads may leave long-term health and psychological scars on local communities. (Strategy&, 2010)

All world regions illustrate the same phenomenon of shifting from slow to faster modes as income and the demand for mobility rise. Variations among regions largely reflect the historical legacy of infrastructures, which partially reflect population density, policies and tastes. Accounting for those differences, our technique suggests that transportation systems behave in deterministic patterns. Over the long term, modes are largely selected by the speed of their service, not (directly) according to policy. (Schafer and Victor 2000, 198)

Schafer and Jacoby (2003) present a model where modal shares of household travel quantity information are aggregated into household "own" transportation via the private light-duty vehicle, DHO, and household "purchased" transport, DHP, which is an aggregate of bus, rail and air. Modal split is fitted by a logistic equation in the growing purchased component, with the own component as a residual. The resulting relationship for the US is presented in the figure below, and the shift from light-duty vehicles to purchased transport, as people increase travel under a fixed time budget, is clearly shown.

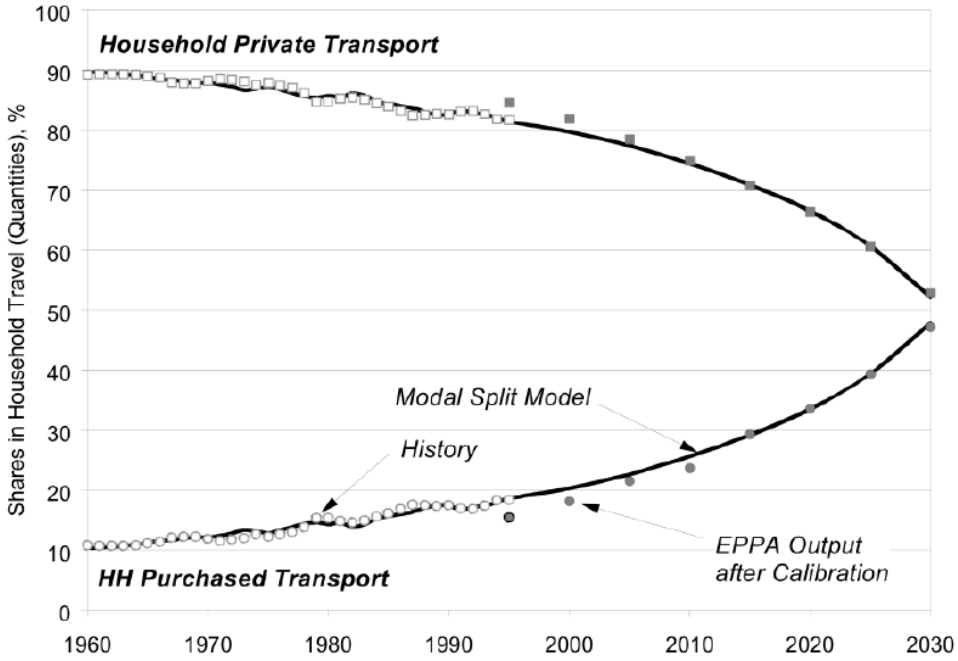


Figure 55 Structural Change in Passenger Transport, Historical Development (1960-1995) and Projections through 2030. (Schafer, Victor 2000, 11)

On average, people spend a constant share of money on traveling; rising income leads nearly directly to rising demand for mobility, which we demonstrate historically (Schafer and Victor 2000, 197). Usually the level of disposable income is an economic Pestel factor but in this case it was marked down as more of a social factor on an individual level and a economic factor on a national level.

4.6 Case company PESTEL E-factor, Ecological or environmental

The existence of Pestel ecological factor should be looked at on a global level. How a company performs in global competition partly depends on how countries and markets compare to each other in the global competition in applying green values as a driver for decision making and how green technical properties are valued in different markets.

In February 2015, the European Commission presented the 'Energy Union' package consisting of three Communications. One of them, entitled 'The Paris Protocol – A blueprint for tackling global climate change beyond 2020', focused on the EU contribution to the 21st UNFCCC Conference of Parties (COP21) which took place in Paris in December 2015. The Communication translated the decisions taken at the European Summit in October 2014 into the EU's proposed emissions reduction target (the so called Intended Nationally Determined Contribution – INDC) for the new agreement. The EU's INDC is the commitment to reduce all CO2 emissions by at least 40% in 2030 compared to 1990 levels. Furthermore, the Communication 'A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy' addressed five dimensions, including energy efficiency. In particular, the Commission stated its ambition to achieve "an energy-efficient, de-carbonized transport sector".

4.6.1 Sustainability in transport

> The technological solutions that we seek must offer transformational levels of improvement. We need to plan infrastructures and use financial leverage from the enormous investments to create zero-carbon infrastructures that feature the intelligent use of renewable energy sources. These will likely include solutions integrating renewables like the electrification of private vehicles and public transportation that runs on electricity and biogas. (WWF 2012, 7)

> The most obvious example of the positive role of urban density is transportation, one of the major components of energy and emissions intensity. For example, in Toronto, transportation emissions per capita are almost four times higher in low-density areas than in high-density areas. Cities with high densities tend to have better-developed public transportation infrastructures and lower transportation emissions. They restrict car use and limit parking spaces, they make cycling and walking attractive, and they provide easy access to public transportation. In short, they plan for more effective transportation (WWF 2012, 5)

> Sustainability, particularly in its environmental dimension, has always been considered a key value of the European rail industry. Rail technologies are already 3 to 4 times cleaner than road or air transport in terms of CO2 emissions (according to ERRAC), but efforts need to be intensified to tackle climate change in the upcoming decades.

> Fast growth and urbanization in Asia and Latin America are a key challenge, but they also provide a tremendous opportunity for more sustainable and liveable environments. Indeed, urban rail networks consume very low urban space compared to the capacity it offers. A rail line carries over 5 000 passengers per hour at street level in the case of light rail, and up to 60 000 passengers per hour on a single track in the case of regional metro. By comparison, a road lane can offer a maximum capacity of 1000 to 2500 passengers per lane per hour, and each car needs a parking place at the end of the journey[4]. Light rail systems are therefore acknowledged as an essential instrument to set up a new sustainable urban development paradigm. (Unife 2014b)

> Air transport and high-speed rail (HSR) substitution has been supported by many for environmental reasons (EC, 2011; TRB, 2013), due to the projected increase in demand for air transport as several large airports in EU are currently operating near full capacity. One of the main statements to justify policies for modal shift from air transport to rail relates to the greenness of HSR on a per seat basis. The European Commission, for instance, while deciding on benchmarks for achieving the 60% greenhouse gases emissions reduction, stated that the majority of medium-distance passenger transport should go by rail by 2050, with the length of the existing high-speed rail network to be tripled by 2030 (EC 2011, 9). Some studies state the opposite that when the level of pollution emitted by HSR is not sufficiently lower than that of the airline, the gain from shifting former air passengers to a cleaner mode of transport is not able to compen-

sate the amount of pollution due to newly generated traffic. (D´Alfonso et. al. 2015, 131)

Givoni (2007) produces a door-to-door assessment of air and HSR travel between London and Paris and normalizes GHG and CAP emissions to their monetary external costs. Givoni's (2007) attributional assessment finds that between London and Paris the CO2 emissions (kilograms per seat) from HSR travel are 7.2 and from air travel are 44. Janic's (2003) attributional assessment estimates that the French TGV emits 4 g CO2 per passenger-kilometre travelled (89% nuclear electricity), the German ICE 28 g (50% coal electricity), and a competing flight between 100 and 150 g. In some cases, especially in the major conurbations until very recently, rail has in effect become less relevant, as city centre development has lost out to 'edge city' suburbanization. For the latter areas, rail never did offer much. If we are serious about sustainable development and tackling greenhouse gas emissions, then combined policies which intensify city centres and urban living densities will be adopted and will go hand in hand with less car dependency and a stronger role for rail. The advantages are huge, if only currently fully experienced in Britain in the core of London: where else in Europe is there a city with a commuting catchment of 20 million people? (Steer 2005, 169)

The case studies showed that there are feasible scenarios under which significant HSR penetration can be achieved in interstate passenger transportation, leading to reasonable decrease in national long-term CO emissions and costs relative to a future case without HSR investment. A renewable electric generation future case, toward which the current trend of generation expansion is leaning toward due to climate change issues, was found to support such high HSR penetration scenarios in a sustainable manner to ensure overall national emissions reduction. The diversification of passenger transportation portfolio with HSR was shown to reduce the national dependence on petroleum consumption, and the consequent vulnerability against shocks in oil import. In addition, it provides passengers with an alternative time-efficient choice for short and medium-distance interstate travel, thereby enabling a shift in the current trend of dependency on light-duty vehicles (LDVs) for interstate passenger travel. Sensitivity studies with respect to LDV mode share revealed that such a change in the passenger mode choice is essential to ensure higher ridership for HSR, and consequently realize national scale cost and emission benefits over the long-term. (Krishnan et. al 2015, 154)

Based on a Japanese Delphi study from National Institute of Science and Technology Policy (Nistep) the Japanese are also mainly working on the environmental issues in transportation to improve the emissions. The Delphi study foresees fuel cell -powered ships and railcars by 2020. Also inter-modality is in the epicentre of transport related development. Development of a system to reduce by 50% the time, cost and environmental load at each node that links a railway and road, road and port/airport as well as a railway and port/airport so as to improve the efficiency of freight transportation between cities by 2020.

Commuting, transport system

Delphi topic (Front numbers represent "panel-topic ID")	year		Importance		Sector leading to tech realization					Sector leading to social realization					
	Tech	Social	W/J	J	Uni	PRO	Ent	Coll	Other	Uni	PRO	Ent	Govt	Coll	Other
2-23: A system under which 80% of office work can be changed into distance work in Japan, that is, where a person can work together with his/her colleagues at different offices with the same communication as if they were at the same office all the time.	2017	2024	+				++					++			
4-59: Design techniques for medical communities and medical cities (such as the residential area for elderly persons)	2018	2024		+		+	+	+				+		+	
1-43: Long life and highly reliable electric vehicle battery technology with high energy density (approximately 3 times as dense as at present) that enables electric vehicles to have a total driving distance on a single charge that is equivalent to that of current gasoline vehicles (approximately 500km)	2018	2025	++				++					++			
2-24: A virtual office system that can halve the number of workers in Japan compared with the present real office.	2018	2025	+				++					++			
6-41: Low-cost secondary cells for vehicles (such as cars) (specific energy: 100 Wh/kg or more, specific power: 2000 W/kg, and specific cost: 30-thousand yen per 1kWh or less).	2019	2025	++				++					++			
11-16: Alternative technology for energy intensive transportation devices for humans to cope with global warming and the escalation of environmental problems.	2018	2026	++				+					+		+	
12-46: Development of a next-generation environmentally-friendly ship (green ship) with 50% less CO_2 emissions and approx. 80% less NOx emissions than present ships.	2019	2026	++				++					++			
12-42: Development of a system to reduce by 50% the time, cost and environmental load at each node that links a railway and road, road and port/airport as well as a railway and port/airport so as to improve the efficiency of freight transportation between cities.	2020	2027	+	+		+	+	+				+	+	+	
9-32: High efficiency fuel cells for vehicles using no rare metals.	2020	2030	+		+	+	+					++			
2-53: Automatic driving technology for automobiles with a special lane that will enable the current usage efficiency of highways to triple.	2020	2031	+			+	+					+	+		

Figure 56 Survey Priority items in science and technology for Japan (Nistep 2010, 16)

To interpret the data above

- Year: "Tech": forecasted time of technological realization (somewhere in the world); "Social": forecasted time of social realization (in Japan)
- Importance: "W/J": important for Japan and the rest of the world; "J": important especially for Japan; "Important for the world" and "Low importance/priority" columns are omitted because of a low selection rate (<40% in all topics)
- Leading sectors (tech/social) (Sectors that will pave the way to technological/social realization): "Uni": University; "PRO": public research organization; "Ent": Enterprise in the private sector (including NPO); "Govt": Government; "Coll": collaboration among multiple sectors.
- Level of "Importance" and "Leading sectors": "++": indicates a selection rate over 70%, and "+": indicates a selection rate over 40% but less than 70%.
- For each category, the topics are arranged in the order of the year of social realization (from earlier to later).

4.7 Case company PESTEL T-factor, Technology

Review made of the independent consultancies shows (Figure 55) these technology and rail specific trends for 2016 and beyond.

Technology specific trends are pointing quite coherently to one direction only. The transformation of Big Data and cloud services are driving new business models and advanced manufacturing methods are expected to

create a paradigm change in the way products are being manufactured to tailored needs of the end customers. In railway business where "return of experience" and "proven in use" are the key terms in decision making advanced manufacturing can be seen as a new flexible way of producing prototypes in development phase.

Trend	Mobile - OS - mobile payment - messaging - maps	Cloud - Enterprise SW -IoT -Automated home -Cyber security	Wearable tech - medtech -IoT - smart watch	IoT - automated home - AI - ambient commerce - cyber security	Big Data - ad-tech - AI - SW analytics - wearable tech	Ecosystems - E-commerce - Enterprise SW - Automated home - Mobile internet	China - Alibaba IPO - Telecom Equip trade war - Variable interest entities - Accounting risk	Regulation - Net neutralicity - Data privacy - Patent litigation - Anti-competition law	Social - Crowd funding - Virtual currency - Sharing economy - Music, video games	Adv. Manufacturing - 3D print - Artificial intelligence - Robotics - Driverless car	Fixed-Mob convergence - fueling business-models such as shared telecom infrastructure
CM research	X	X	X	X	X	X	X	X	X	X	
Gartner		X		X	X	X				X	
Gartner		X		X	X					X	
Deloitte	X	X		X		X				X	
PWC	X				X			X	X		X
Kjaer global			X		X				X		
Rail specific	Urbanisation Mega cities	Asia booming	New business models	CO2 footpring/ECO	Fuel price	Geographic variety	Multimodality	Zero emission	Mobility	Deregulation Liberalization	New lines
Frost&Sullivan	X	X	X	X	X	X	X	X	X		
Amadeus							X			X	X
SCI Vehrker	X	X		X		X					X
Unife	X			X						X	

Figure 57 Tech trends by consultancies research (Korhonen, 2016)

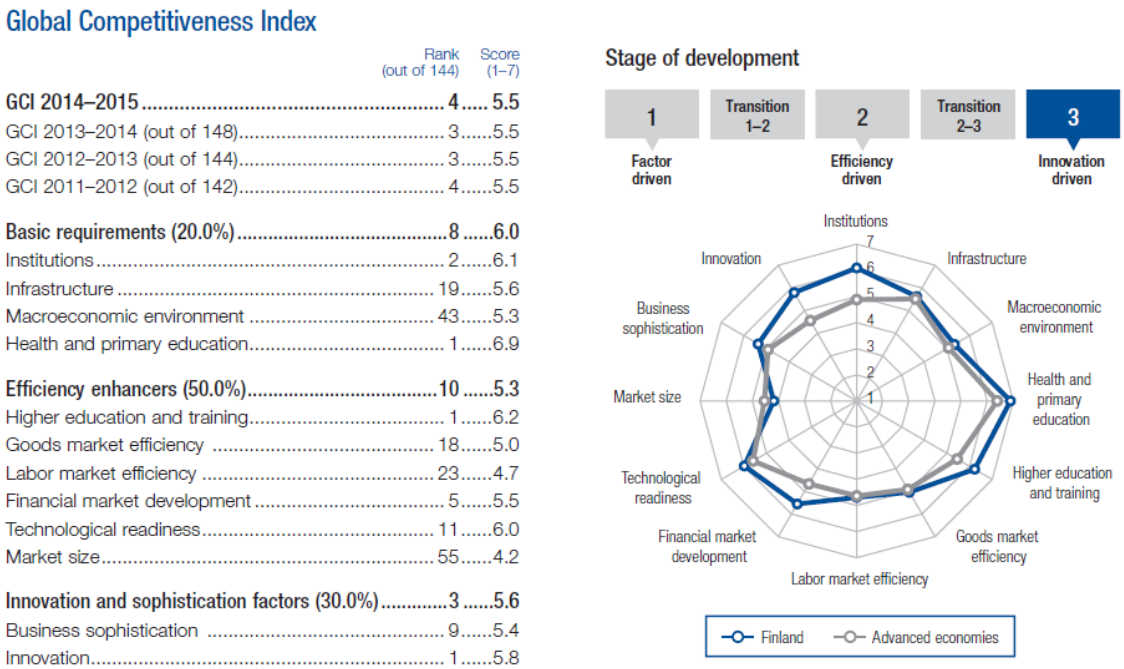
Rail specific trends from independent research companies point of view is somewhat scattered. It paints a picture of lack of understanding of the branch and that the size of the business is quite small compared to e.g. automotive industry. The only industry specific driver that is found convergent is multimodality. It means that there is increasing use of more than two modes of transport daily and those modes of transport should be well connected with each other.

4.7.1 Finland as a country of innovation

In this thesis the researcher cannot report on the company`s ability to innovate and do product development. Alternative approach is to look into the country level ability to innovate and how the country is positioned in its capacity to innovate.

As basis for the ability to innovate according to WEF study 2015 Finland's biggest competitiveness strength lies in its capacity to innovate, where the country leads the world rankings (1st). Very high public and private investments in R&D (3rd), with very strong linkages between universities and industry (1st) coupled with an excellent education and training system (1st) and one of the highest levels of technological readiness (11th) drive this outstanding result. (WEF 2015, 21). In 2017 the results

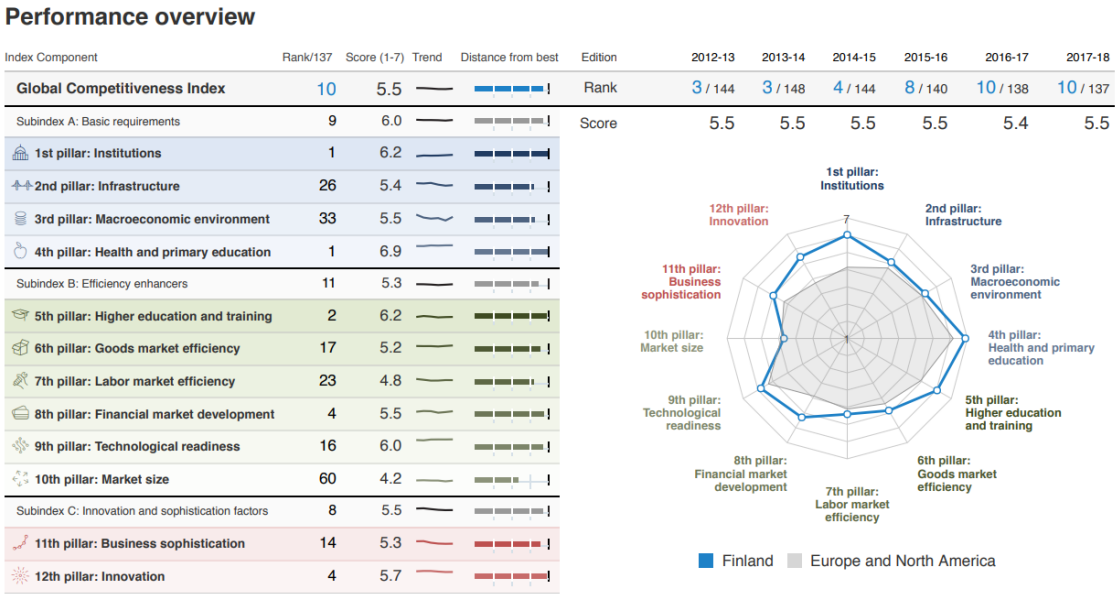
show some decline in global ranking (WEF 2018, 118) being 10th that year.



Global Competitiveness Index

	Rank (out of 144)	Score (1–7)
GCI 2014–2015	**4**	**5.5**
GCI 2013–2014 (out of 148)	3	5.5
GCI 2012–2013 (out of 144)	3	5.5
GCI 2011–2012 (out of 142)	4	5.5
Basic requirements (20.0%)	**8**	**6.0**
Institutions	2	6.1
Infrastructure	19	5.6
Macroeconomic environment	43	5.3
Health and primary education	1	6.9
Efficiency enhancers (50.0%)	**10**	**5.3**
Higher education and training	1	6.2
Goods market efficiency	18	5.0
Labor market efficiency	23	4.7
Financial market development	5	5.5
Technological readiness	11	6.0
Market size	55	4.2
Innovation and sophistication factors (30.0%)	**3**	**5.6**
Business sophistication	9	5.4
Innovation	1	5.8

Figure 58 Global competitiveness index, Finland (WEF 2015, 180)



Performance overview

Index Component	Rank/137	Score (1-7)	Trend	Distance from best
Global Competitiveness Index	10	5.5		
Subindex A: Basic requirements	9	6.0		
1st pillar: Institutions	1	6.2		
2nd pillar: Infrastructure	26	5.4		
3rd pillar: Macroeconomic environment	33	5.5		
4th pillar: Health and primary education	1	6.9		
Subindex B: Efficiency enhancers	11	5.3		
5th pillar: Higher education and training	2	6.2		
6th pillar: Goods market efficiency	17	5.2		
7th pillar: Labor market efficiency	23	4.8		
8th pillar: Financial market development	4	5.5		
9th pillar: Technological readiness	16	6.0		
10th pillar: Market size	60	4.2		
Subindex C: Innovation and sophistication factors	8	5.5		
11th pillar: Business sophistication	14	5.3		
12th pillar: Innovation	4	5.7		

Edition	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Rank	3 / 144	3 / 148	4 / 144	8 / 140	10 / 138	10 / 137
Score	5.5	5.5	5.5	5.5	5.4	5.5

Figure 59 Global competitiveness index, Finland (WEF 2018, 118)

It is noteworthy that the overall score has not decreased from 2015 to 2017 but the ranking has declined due to other countries improving more than Finland in comparison. What seems to hurt Finland the most in comparison are the domestic market size which we can not change that much but what could be changed by legislation is freeing up the labor market, lowering income tax and relaxing tax regulations (WEF 2018, 119).

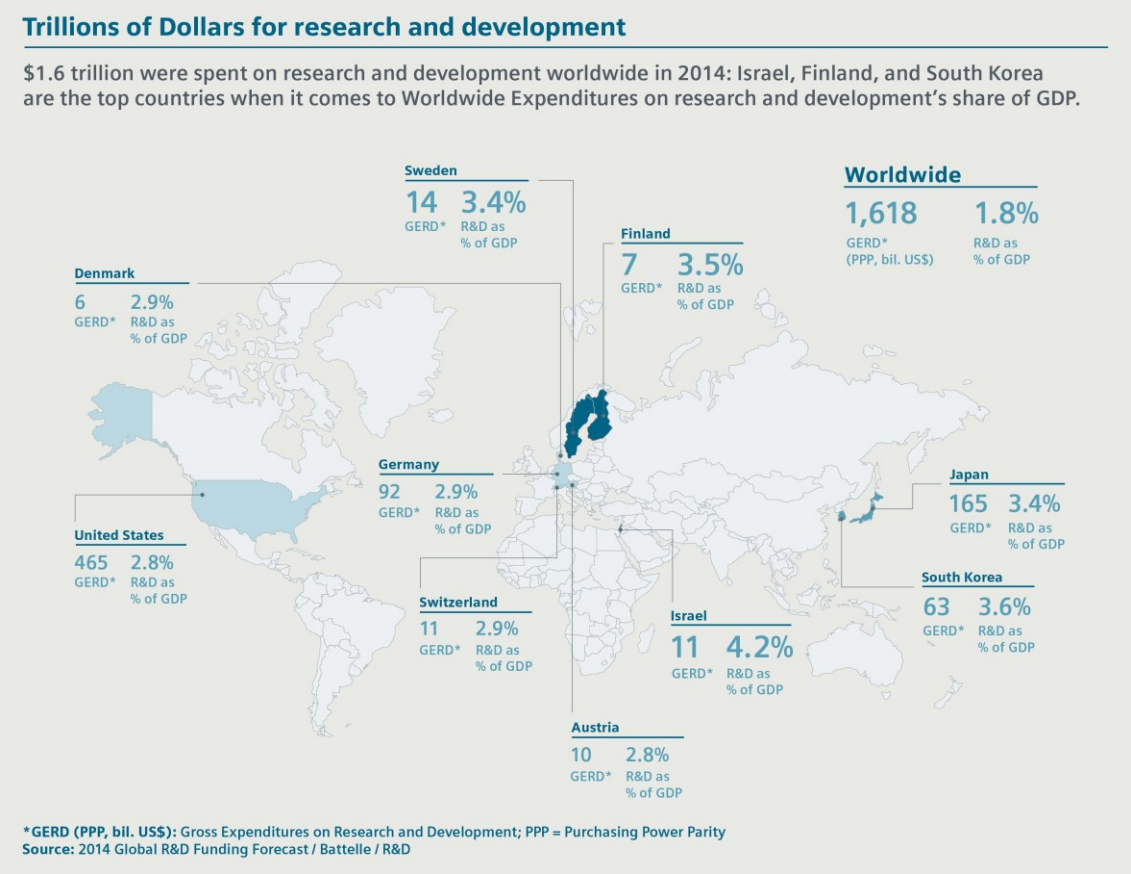


Figure 60 Research & Development expenditure, share of the GDP 2014 (Battelle 2014)

Finland is according to Battelle (2014) one of the leaders in global research and development expenditure measured in share of the GDP. With a 3.4% share Finland is left 3rd with only South Korea and Israel in front and the forecast for 2018 keeps the statistics the same according to R&D magazine forecast (2018).

4.8 Conclusions of PESTEL factors in the case company

The researcher finds that this business area is in an ideal position from major Pestel and megatrends point of view. There are several factors that drive market growth possibilities giving the company a great leverage to develop its product portfolio further and finance it with sales activities. Population growth and urbanization drive the need for better mass transport solutions and very few of them are more efficient in terms of ecological sustainability and carriage capacity that is needed in large cities.

As Schumpeter argued (1950, 83) the fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates.

Some of the **supporting** findings for the business area are environmental regulations that are becoming harder to comply with, rule of law and regulation making the technology base more stable. Continued economic

growth, impact of globalization, population growth rate contributes to investment decision making ability to put in place expensive infrastructures that railway requires. Emphasis on safety and attitudes towards social mobility, population employment patterns, public opinion, and lifestyle choices and attitudes to these contribute on an individual level to select railway as the mass transport method of choice for the daily commute to work if accessible.

Technological factors include R&D activity, technology incentives and rate of technological change and the impact of emerging technologies that bring on new young labour force into the business area. Ecological or environmental drivers for railway transport are the strongest of them all. climate change, environmental taxes and demand for "green" products are considered when comparing individual and mas transport solutions introduction into urban areas.

Legal factors are strong in railway manufacturing business with antitrust laws with product liability and health & safety laws.

Some of the factors for the case company working from Finland could see as **negative** factors from Pestel analysis are tax Finnish policy, rigid employment laws, trade restrictions to some markets along with political stability, government type, freedom of press, rule of law, levels of bureaucracy and corruption.

Economic and social factors can include the impact of Brexit, ex-change rates, labour supply, labour costs, job market freedom with attitudes to work lifestyle choices. There is for example a trend that younger workers are no longer interested in staying in one company for a long time but prefer to look for different things in the work market.

Technological and ecological factors can include e.g. impact of emerging technologies, increased remote working, environmental taxes.

4.9 Railway supplier SWOT

Pehrsson (2009), building on insights of Shepherd (1979), has recently stated a barrier to entry can be classified exogenous or endogenous. Exogenous barriers are the ones that are entrenched in the underlying market conditions. Therefore, companies cannot control barriers at issue. These include for example incumbents' product differentiation, need for capital for the establishment, customers' switching costs, number of competitors and government policy. On the contrary, endogenous barriers are generated by the companies through the market strategies and the competitive behaviour. These barriers are based on incumbents' reactions towards new entrants' establishment plans, for example incumbents' price competition and its reactions in general. (Pehrsson, 2009)

From a Porter Five Forces perspective, numerous market entry barriers exist to protect the incumbents in western European market against new players.

Figure 61 Market entry barriers to railway business (Korhonen 2016)

European companies tried to put up even a higher barrier for homologation in the form of a specific quality system for railways called IRIS but within the first years of application it was realized that most of the qualified companies were Chinese. In 2016 the requirements still burden the manufacturing and sourcing in downstream direction with qualified materials and process requirements. Even with these measures incumbents had to give way to new players at the top. This development has realized through the enormous home market in China and to increasing extent in Russia.

Key inputs in this market are diesel fuel and traction power, rolling stock, and railway engineering products and services. All of these are provided by a small number of large organizations, which tends to strengthen supplier power. Few substitutes are available, and quality is highly important, especially in safety-critical areas, which also strengthens the power of the suppliers. On the other hand, suppliers of rail-specific products have few options but to sell to the train operating companies, which strengthens the bargaining position of the latter. Overall, supplier power is assessed as moderate. (Marketline 2015, 14)

Figure 62 Drivers of supplier power in the global railroads sector, 2015 (Marketline 2015, 11)

The case company SWOT is confidential suffice to say it takes into consideration the portfolio of products and their impact on the ability to increase the bargaining power in a contract situation similar as in the general railway supplier SWOT depicted above.

4.10 Case company customer`s product portfolio thinking

Based on research apparently the customers of the case company are using portfolio management as one of the methods and drivers for market strategy in entering into new markets and staying competitive in them. In order to have a product portfolio you need an innovation portfolio to funnel ideas from initial conception to product development. Innovation portfolio is more of a collection of concepts loosely organized around an emerging strategy driven by the future. Project portfolio is applied to managing products that have passed innovation funnel stage gates and are in development phase and guided by a clearly defined product strategy. A ready product portfolio is an indication of an existing process of portfolio thinking. In the picture below there is an example of an OEM product portfolio from Bombardier transportation.

	Rolling stock						System integration	Signalling	Head-quarters
	Light-rail	Metros	Commuter and Regional	High speed and Intercity	Loco-motives	Monorail			
BT	●	●	●	●	●	●	●	●	Germany
Alstom	●	●	●	●	●		●	●	France
Ansaldo[1]	●	●	●	●			●	●	Italy
CAF	●	●	●	●				●	Spain
CNR[2]	●	●	●	●	●				China
CSR[2]	●	●	●	●	●	●[3]			China
GE					●			●	U.S.A.
Hitachi			●	●		●	●	●	U.K.
Kawasaki		●	●	●					Japan
Rotem		●	●	●	●			●	Korea
Siemens	●	●	●	●	●		●	●	Germany
Stadler	●	●	●	●					Switzerland
Thales								●	France

Figure 63 Product portfolio in rail industry (Bombardier, 2015b)

In the picture above Bombardier is comparing its product offering to its main rivals in the market by classifying its train platforms into light rail, metros, regional trains, intercity trains, locomotives and monorails. It also compares its services portfolio by featuring system integration i.e. turnkey services and signalling system scope. In an attempt to differentiate, the statement of the portfolio is that "whatever you need we have it". This appeals to a decision making that is country and government driven where versatility is the key in equipping intercity travel, city trams and signalling to have a full system turnkey delivery from one company and one point of purchase. It may not appeal as much to a private company buying just trams for one city in a most cost-efficient way.

Another portfolio view example is from Alstom and it also covers a more systemic business ecosystem view including services, signalling, systems and rolling stock.

Figure 64 Alstom Shareholders' Meeting, portfolio view (Alstom 2014)

As the latest development in the market Alstom and Siemens mobility are in a process of combining their businesses and consequently their product portfolios. In a joint press conference (Press conference, 2017) on September 27th 2017 Siemens CEO Joe Kaser said that the pace on the industry have accelerated and economies of scale are more important. Both

companies have been analysing the best fit for shareholders, market, employees and customers because mobility has enormous future potential and their portfolio from product and geographical market presence point of view is an excellent match.

All of the case company OEM customers have a product portfolio or as they call it train platforms that feature different solutions to different type of traffic that the trains travel. When a high capacity tram has the sole purpose of transporting as many people as possible between stops in a urban area with great accessibility another platform for high speed intercity travel has a few stops but places a lot more emphasis on the comfort of travel and availability of entertainment for a travel time that may be hours long.

Deriving from that fact it is apparent that the subsystems in that train platform carry different characteristics and compete in different ways in different end-product use therefore there is benefit in having a portfolio thinking hat on when conceiving and producing the subsystems.

4.11 Railway OEM SWOT

Understanding case company`s railway OEM customer SWOT may help in addressing the challenges they face in the market and by helping them overcome those weaknesses and threats place the case company in a better competitive position compared to their rivals.

Below there are some OEM customers SWOTs from the last available Marketline studies in 2013-2015. Situations may have changed a little since then but if it is apparent some additional comments are made with 2017 or 2018 reference.

Alstom SA SWOT

ALSTOM (Alstom or 'the group') is engaged in offering rail transport equipment, systems, services and signalling for urban, suburban, regional and main line passenger transportation, as well as for freight transportation. The group primarily operates in Europe, Asia Pacific, North America, and Middle East and Africa. Alstom is headquartered in Levallois-Perret Cedex, France and employed 87849 people as of March 31, 2015. During 2015 there was a considerable divestment of businesses to enhance focus on rolling stock and improve efficiency. Now in 2018 Alstom is entering into a merger with Siemens, which is expected to be completed by the end of the year and will create the world's top firm for rail signalization and the No. 2 for building train carriages. Combined turnover will be in the range of 16Bn Euros second only to the Chinese CRRC, which has been formed by two national groups, already reaches € 30 billion.

Strengths	**Weaknesses**
Worldwide presence helps to serve a broad range of customers and markets Strong focus on research and development enhances market competitiveness and business growth	Alleged anti-competitive activities impacts reputation and financial position Weak financial health could weaken competitive strength
Opportunities	**Threats**
Positive outlook of global passenger rail sector New orders to provide incremental revenue growth Divestment of businesses to enhance focus and efficiency	Intense competition could strain margins Currency risks could impact financial position Complex homologation procedures for trains could impact revenues

Figure 65 Company SWOT (Marketline 2015a)

Bombardier Inc.

Bombardier Inc. (Bombardier) designs, develops and manufactures aerospace and rail products. The company designs, manufactures and sells various types of business, commercial and amphibious aircraft; and trains, rail vehicles, propulsion controls and bogies. It also offers jet travel and aircraft solutions, fleet maintenance and aircraft services, and staff training services. The company's portfolio of services also includes fractional jet ownership, charter brokerage services, jet card programs, and whole aircraft ownership and management. It operates with 79 production facilities and engineering sites in 27 countries, and a worldwide network of service centres. The company has operations in more than 60 countries across America, Asia Pacific, Middle East and Africa and Europe. Bombardier is headquartered in Montreal, Quebec, Canada. In May 2014, the company's Transportation division acquired 100% stake in Rail Signalling Services (RSS), a provider of signalling engineering and services based in Australia. In December 2017 Bombardier Transportation employed 37400 people globally with a 7.5Bn Euro turnover.

Strengths	**Weaknesses**
Broad Product Portfolio	Legal proceedings
Diversified geographical presence	Limited Financial Position
Strong Market Position	
Strong Operating Performance	
Opportunities	**Threats**
Growing Demand for Aircraft	Fixed Price Contracts
High-speed railway network expansion plans in Turkey	Government contract compliance
New contract wins	Stringent Regulations
Strategic Growth Initiatives	

Figure 66 Company SWOT (World Market Intelligence 2013a)

Hitachi, Ltd.

Hitachi, Ltd. (Hitachi) is a global electronics company, offering its systems, products and services to a broad range of markets. The company`s products portfolio includes information systems, environmental, industrial and transportation systems, power systems, and social and urban systems. Additionally, the company offers biometric digital signature technology solutions based on biometric information such as finger vein pattern. Furthermore, the company provides semiconductor equipment, construction machineries, automotives, digital media and information storage media devices. In addition, the company provides financial services, logistics and property management services. The company`s international operations include Asia, North America and Europe. Hitachi is headquartered in Tokyo, Japan. In March 2013 Hitachi employed 323,540 people globally. Mitsubishi heavy industries is involved in co-development with Hitachi. Their mixed product lineups include conventional commuter trains for subways and other systems; new transportation systems such as automated people movers (APM) and light rail transit (LRT); and monorails. In 2015 Hitachi has acquired the rail and signalling operations of Ansaldo Breda. Hitachi acquired Finmeccanica's entire a stake in Ansaldo STS S.p.A., representing approximately 40% of its issued share capital, for €761m.

Strengths	**Weaknesses**
Diversified business operations	Declining operational performance
Diversified geographical presence	Ongoing litigations
Focus on R&D	
Strong liquidity position	
Opportunities	**Threats**
Increase in demand for energy	Foreign currency fluctuations
Positive outlook of construction equipment market in Japan	Stringent regulations
Strategic acquisitions	Volatile input prices
Strategic growth initiatives	

Figure 67 Company SWOT (World Market Intelligence 2013b)

Kawasaki Heavy Industries, Ltd.

Kawasaki Heavy Industries, Ltd. (KHI) is a diversified conglomerate with interests in road and transport, aviation, ship building, defense, industrial goods and energy markets. The company, manufactures and sells a wide range of equipment for industrial plants, aircraft and jet engines, ships, gas turbine power generators, rolling stock, and a broad spectrum of manufacturing equipment and systems. KHI also offers industrial machines ranging from turbines and diesel engines for land and sea to aero- and hydro-power machinery. These products are offered under the Kawasaki brand. In addition, the company also has two shipyards at Kobe and Sakaide in Japan. Under the Rolling Stock division, KIH provides wide range of rolling stock, including Shinkansen, electric cars, passenger coaches, freight cars, locomotives, diesel locomotives, and new transit systems. The Rolling Stock division accounted for 10.20% of the company's total revenues in FY2012. In 2017 the share of operating margin attributed to rolling stock was 26% with a total sales figure of 1,08Bn euros. The company operates in Japan, North America, Europe and Asia. KHI is headquartered in Minato-ku, Tokyo, Japan. In December 2013 KHI employed 33,267 people globally and end of 2017 35,800 people.

Strengths	**Weaknesses**
Diversified business portfolio	Product recall
Focus on R&D	
Strong liquidity position	
Strong order backlogs	
Opportunities	**Threats**
Business wins	Foreign exchange risk
Increasing demand for energy	Stringent regulations
Positive outlook of global automotive industry	
Positive outlook of global construction industry	

Figure 68 Company SWOT (World market Intelligence 2013d)

5 APPLYING THE FORWARD LOOK INTO STRATEGY

In this chapter the researcher proposes a tool to be used in the case company. It is generalized to the level that it remains usable and in this thesis report does not go into specifics of how it is organized in the case company. Each of the main activities of the process are explained for its main purpose.

The process core takes its main structure from a familiar Kaplan-Norton strategy cycle but is adapted to an extent. The figure below depicts a management framework that lacks a foresight-scenario-portfolio. There is the basic strategy loop and how it links with operations and management system. This is quite familiar to many who are interested in management and strategy work.

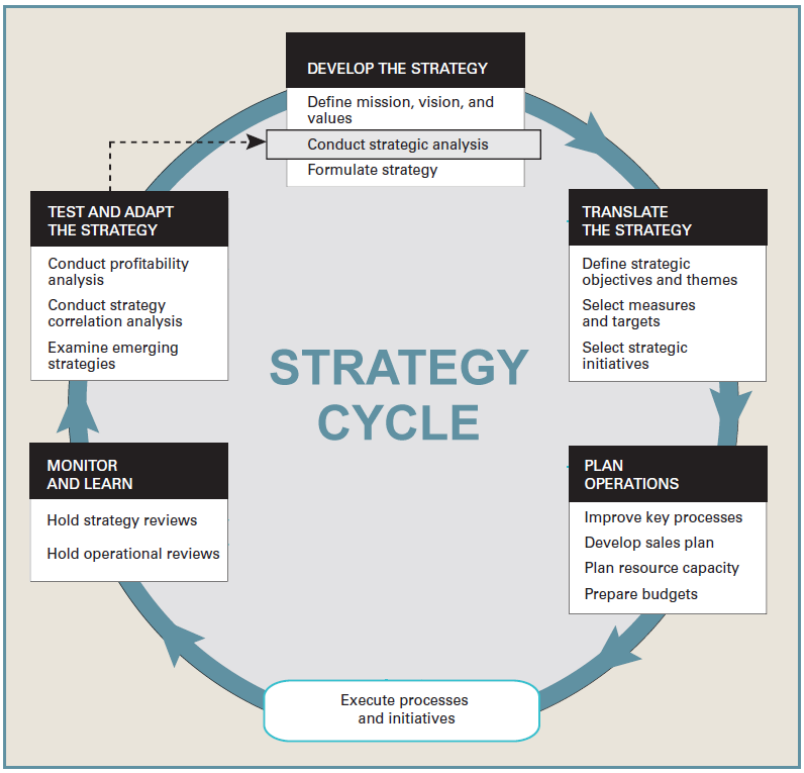


Figure 69 Management system, Adapted from Kaplan and Norton (2008, 65)

To apply other more advanced tools relating to forecasting and product management into the same management framework it is better to describe that in a different format. The researcher proposes a "Strategic closed loop management system" that incorporates market intelligence input and capturing the signals from periphery and allows the adjustment of strategy, product portfolio and therefore extended competitive advantage through a learning loop.

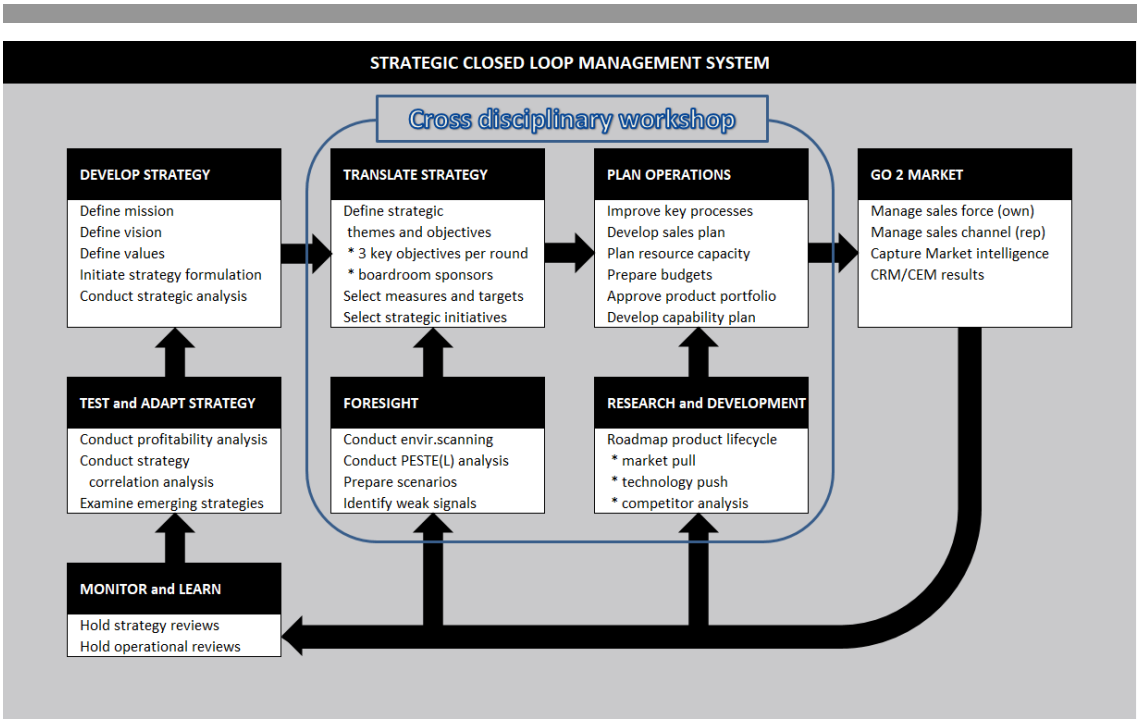


Figure 70 Strategic closed loop management system (Korhonen 2016)

5.1 Develop the strategy

The management cycle begins with articulating the company`s strategy. If applied on BU level it will take one additional input from group level. The development normally occurs in a top management meeting where the team either incrementally improves or sometimes introduces a new strategy. Creating a mission and vision has a lot of analytical and qualitative thinking behind it and it should address the basic statements such as; what business are we in, what business we are not in, why and does it have a future. The strategy statements (mission, vision) must be crystallized in a sentence or two clarify the company purpose, future aspirations and values. All the business classics are in play in formulating the strategy: Collins and Porras BHAG`s (big, hairy audacious goals) Porter Five forces, market position by different matrixes and SWOT`s considering disruptive elements, blue oceans and resource based view. Quantitative elements come from profitability analysis based on market and customer and product split, different trends analysis like linear market growth, product adaptation curves and Gartner hype cycle if it is applicable to the offering.

5.2 Translate strategy

Once that strategic positioning has been formulated it is the researcher's proposal that the individual departments take a moment to evaluate the impact on each discipline. After a sense making period managers need to translate it into objectives, measures to be taken, organizational adjustments to have and activities to take, measure and follow up. Depending on the tools in use a company could use strategy maps, balanced scorecard

and relative KPI`s to reach the goals planned. It is advisable to have a short list of well-focused strategic themes and objectives to work on that have a sponsor in top management. Researcher proposes that foresight is applied at this point of the process to allow emergent change to seep through to strategic intent. As suggested by several researchers it is beneficial to apply methods from quantitative and qualitative ends of the spectrum and combine them into a peripheral view through a structured discussion. To understand social complexity and allow testing new practices through heuristic analysis of the emergent future the sessions should use participatory methods to combine the input of mathematical, systemic and engineering approaches of the futures method tools.

5.3 Plan operations

Planning operations is present in every working day of a company. With objectives in place operational planning has a much better change to accomplish its strategic objectives. Operations are only one of the methods a company can use to improve profitability and strategic alignment. Managers need to deconstruct strategic intent into critical success factors and plan the required capabilities, required improvements in processes or modified product offering to fulfil the objectives. That brings in the R&D department with its unique view on technological progress, modularization opportunities, market pull and developments in the field of competition. Tools to apply vary depending on the nature of business. Product based business can apply e.g. time driven activity based costing and project business can use more dynamic costing models.

5.4 Go to market

With all the products, services and processes in line with strategy it is easy to go to market. Not going into details about sales and channel management processes the researcher would like to point out that it is one of the most important tasks of sales to bring the information back into the organization to feed the learning loop with market intelligence for the organization to be able to react to emerging change and customer feedback. In addition to lack of future vison and organizational rigidity this may be one of the most important reasons companies stagnate or lose in global competition.

It is also very important to understand and take on the attitude that every customer engagement on every organisational level is an opportunity to learn about the market and find the opportunities to augmented sales. Service and after sales is a very important discipline in an industrial manufacturing organization so the sales of spare parts and connected services takes its input from product commissioning visits and first mounting inspections. The organization needs reporting from every visit so that the salesforce can form a picture of the current and future needs.

5.5 Monitor and learn

As a company implements its strategy it is relevant to follow up how the strategy works and monitor progress and learn from the results. In the case company claims, late deliveries, defects and project status are followed up on a weekly basis. Strategic reviews can be fitted into where it best serves the purpose - making sure the activities are aligned with strategy. It could be in a project review, business review, audits and the purpose is either to align the activities to match the strategy or adjust the strategy to meet the need. Meetings should be proactive and participatory instead of listening to reports made on dashboards. It is advisable to think about the gaps and solutions and engagement. Rather deep dive into strategically important themes than scratch the surface of every discipline.

Understanding the future often requires knowing about the past and the learning loop should engage the workforce that has tacit knowledge and strong experience on the business area.

5.6 Test and adapt strategy

Testing how strategy works is closing the loop of the management system. Cost and profitability reporting, proper breakdown analysis of how the offering is taken in the market place is essential. Understanding the economics and emerging opportunities and threats is vital. This is the loop where a company can decide how to manage customers and products to move them to the next quadrant of the profitability matrix. With adjustments to strategy a company can test which approach yields the best results.

Arranging business reviews with key customers bring the company strategy visible to the customers. It is important to let customers know that the company is being developed and there is a clear vision to improve competitiveness in business where project delivery cycles can last 10 years. In these hopefully proactive and two-directional talks the company gains information of its customers standpoint on strategy and it is tested for response. Remembering that customers may not agree on the good impact that company is taking out competition by making acquisitions of their competitor companies it does show strength nonetheless and in long cycle business you need strong and vital suppliers that can absorb some risks as well.

5.7 Research and development

R&D compliments the operational planning process by bringing in the market intelligence regarding product offering and its competitiveness compared to competitor’s products and emerging transformational techniques. It also bridges the gap to market pull by the notion that salesforce is asking for solutions that may be in the future plans of the key customers. It can also take into account possible legal aspects of the PESTEL analysis through patent analysis and changes in relevant laws, standards and de-facto standards. Some companies also take part in designing the

standards that form the basis of product compliance in the market. Strongest driver of profitability is a rigorous new product process with tough go/nogo-gate, early product definition and flexibility to decide otherwise. Senior management commitment to product introduction is also crucial to success.

5.8 Foresight

Foresight is an important part of any company that looks after its competitive position in the market. Foresight should be the responsibility of every management, sales, development and aftersales oriented person in the organization. It is advisable that the whole customer facing interface of the company uses a futures radar (Korhonen 2014) to investigate the possible emerging threats, opportunities and industry transforming phenomenon that may occur. This can easily be organized through a short questionnaire to be presented at customer facing situations or at different stages of the CEM process. The foresight link utilizes appropriate tools to scan the periphery and make sense of the emerging themes. Foresight requires participatory methods to yield visionary signs of the future a company can act on.

6 NEED TO STUDY FURTHER

In this Master´s thesis the end result was laying the foundations for a future looking strategy cycle. It may be advisable that future tools are taken into use step by step and compare the application results with the traditional way of working in the company. It must be understood that this is also a cultural change in nature and not only a change in process or tools. Mastering the approach requires practice and requires internal promotion to be well rooted in the corporate culture. In the long run the organization could be developed into a direction where different stakeholders have different roles in the process and are committed into the process by involvement and accountability.

The frameworks developed in this study should help managers to understand and structure the complicated phenomenon and concept of demand risks that may arise from megatrends and weak signals from customer engagement occasions. Being aware of the phenomenon causalities and the vulnerabilities that risk exposure entails should enhance the cognitive capacity among members of the management and customer facing personnel. It may prove to be surprising how poorly prepared any organization may be for any disruption no matter how small.

This research has highlighted the importance of reflection in management and how uncertainty plays a crucial role in the strategy process. It opens a further path of research to study barriers to adaptation of foresight its impact on competitiveness and methods of foresight for a SME in a larger sample to provide a scientifically more generalized and repeatable result.

7 SUMMARY

Digitalization, urbanization, congestion and environmental concerns are key drivers for many businesses. They all contribute to popularisation of mass transport if the industry answers the questions this time and age has. Simultaneously traditional competitive forces like technical features of the product, price, operational efficiency weigh in the scale when operative buyers are making their sourcing decisions. Past performance plays the role of creating the base for trust but the ability to lead the way in technological development of the industry and being able to compete globally are the key factors in company level performance.

This is the age of the customer. Everything is comparable globally and there is more information on how the price of the product is constructed so there is no escape. The company has to be able to provide added value and show it is worth the price difference proposed. The only way to keep ahead of competition is to look into the future and apply the methodology on a strategic level in the company processes.

The main finding of the thesis is the integration of futurological approach to strategy process that allows application of different methodologies identified and to enrich the findings with the knowledge existing in the company. Process proposed will be tested in the company and time will tell if this brings with it a forward looking, customer engaging product development programme that fills the gaps in the product portfolio and improves company position in the market.

Companies may tend to look too much at the processes and KPI`s more than the actual data that has been collected. Whichever way you look at it the survival of the fittest is a statement that remains true. The ones being able to adapt flourish and stagnated ones perish.

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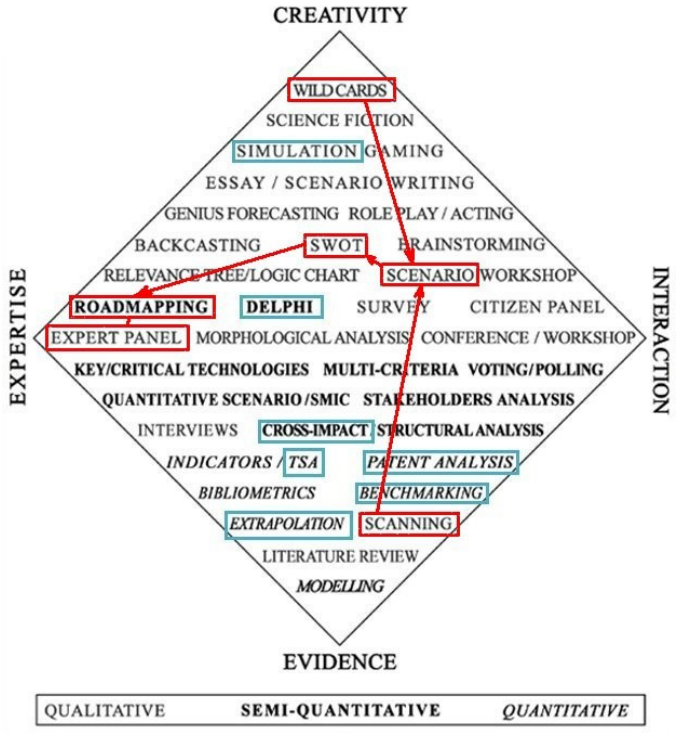
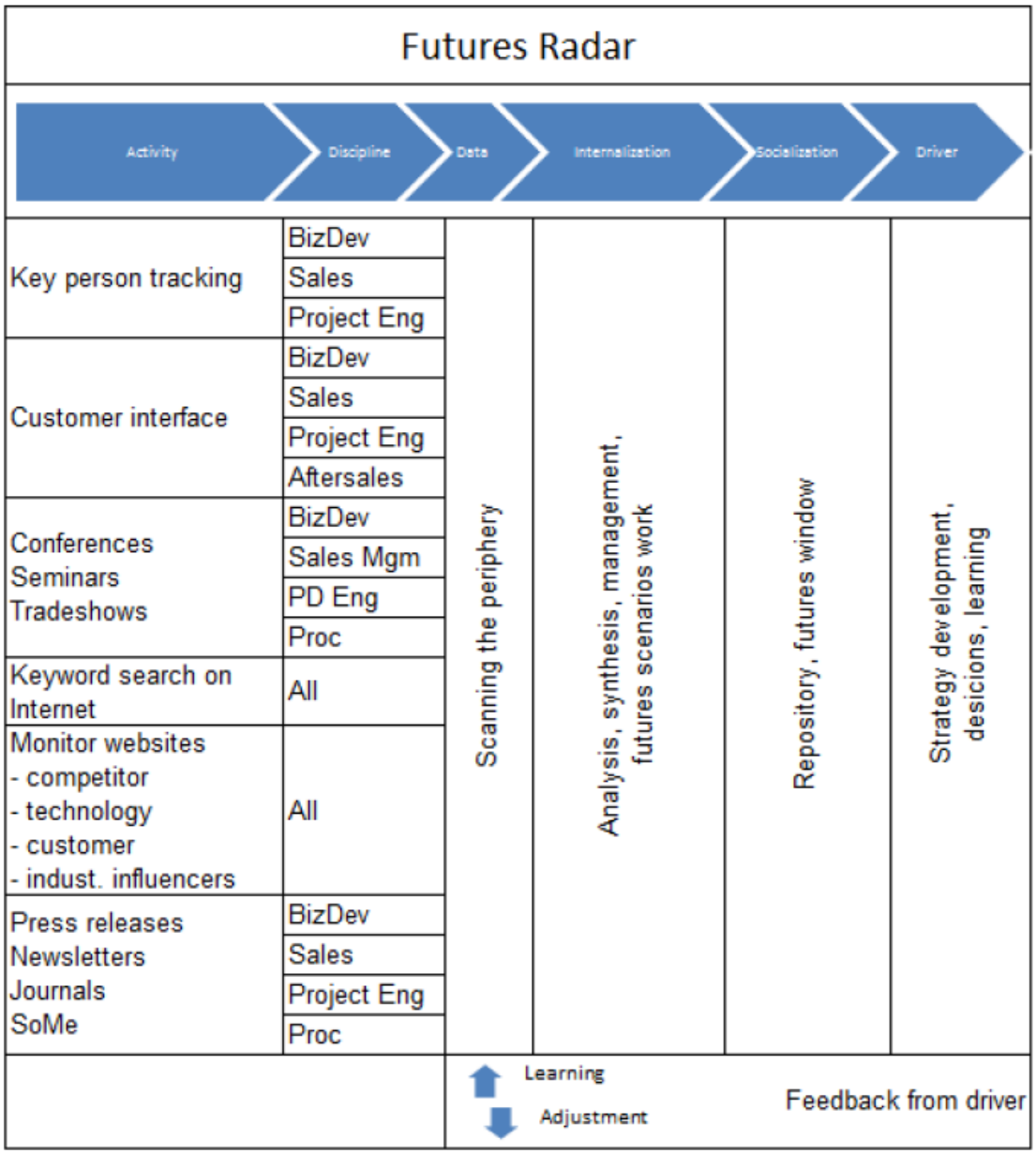
9 APPENDICES

9.1 Appendix 1. Tools (fig 33) as larger pictures for legibility




Futures Radar
Activity
Discipline
Data
Internalization
Socialization
Driver
Key person tracking
BizDev
Sales
Project Eng
Customer interface
BizDev
Sales
Project Eng
Aftersales
Conferences
Seminars
Tradeshows
BizDev
Sales Mgm
PD Eng
Proc
Keyword search on Internet
All
Monitor websites
- competitor
- technology
- customer
- indust. influencers
All
Press releases
Newsletters
Journals
SoMe
BizDev
Sales
Project Eng
Proc
Scanning the periphery
Analysis, synthesis, management, futures scenarios work
Repository, futures window
Strategy development, desicions, learning
Learning
Adjustment
Feedback from driver

9.2 Appendix 2. Tools (fig 70) as larger pictures for legibility